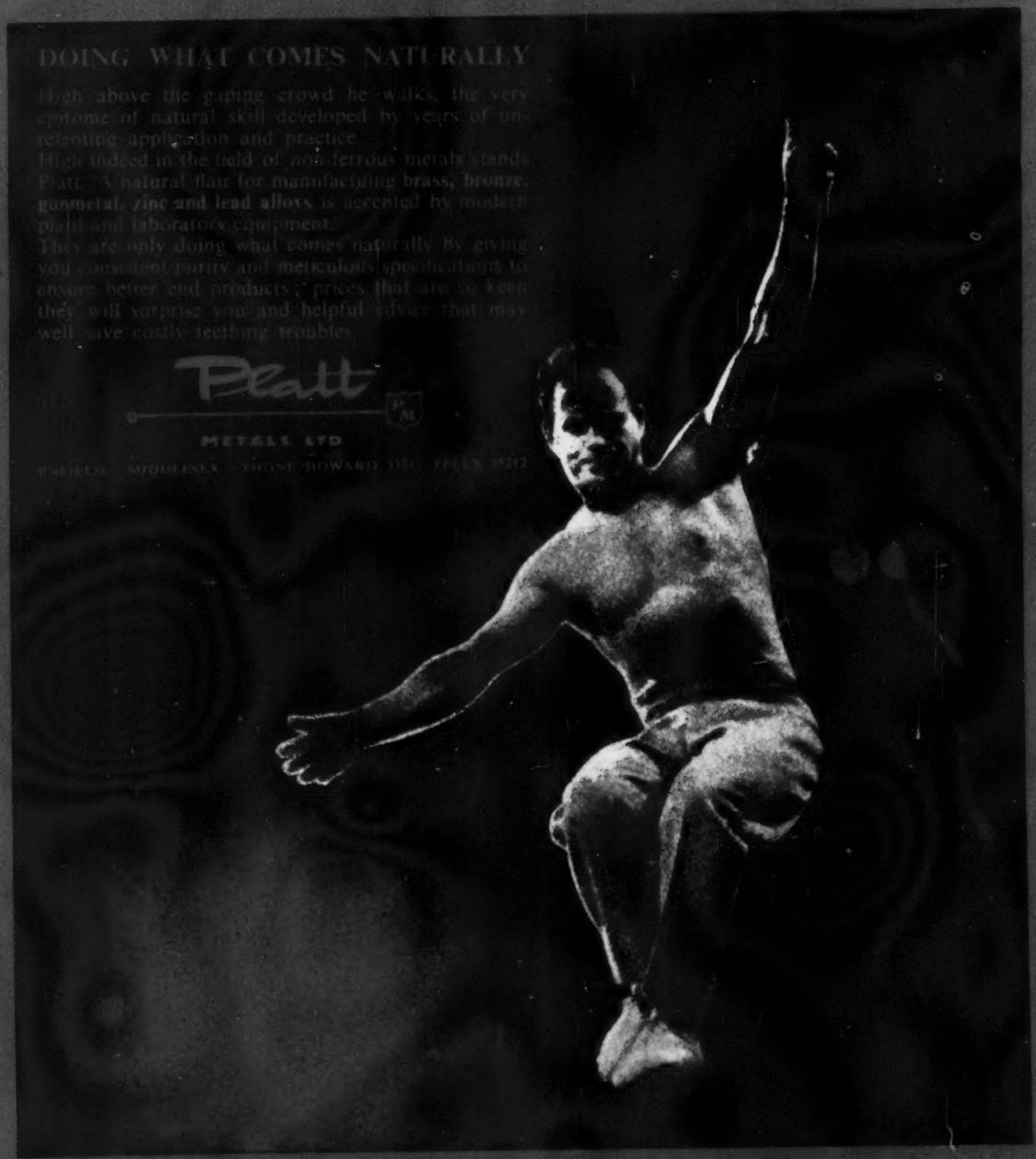
21 APRIL 1961

METAL INDUSTRY

THE JOURNAL OF NON-FERROUS METALS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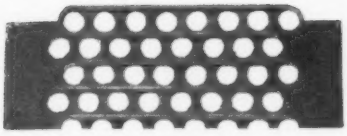

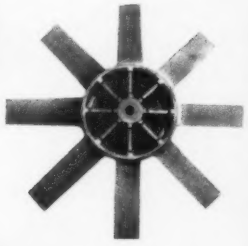

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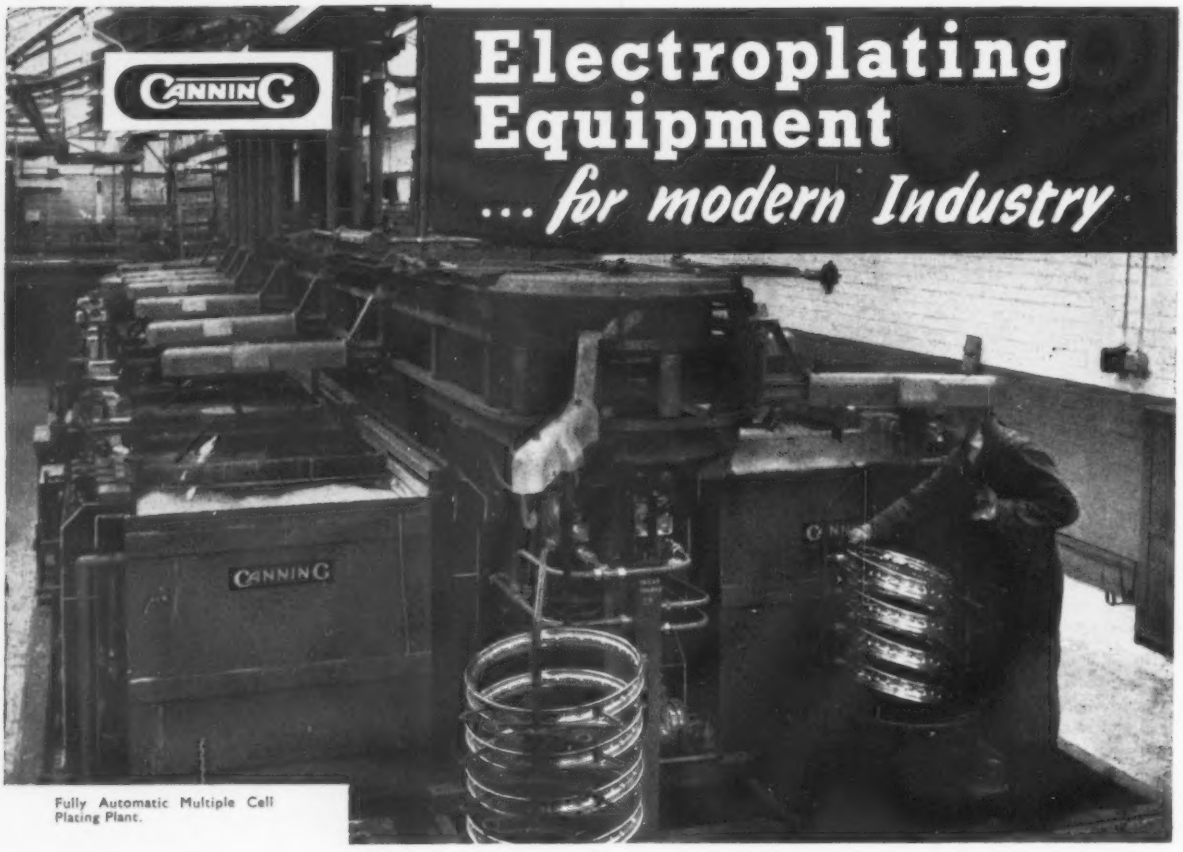

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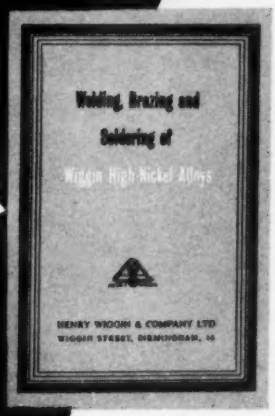

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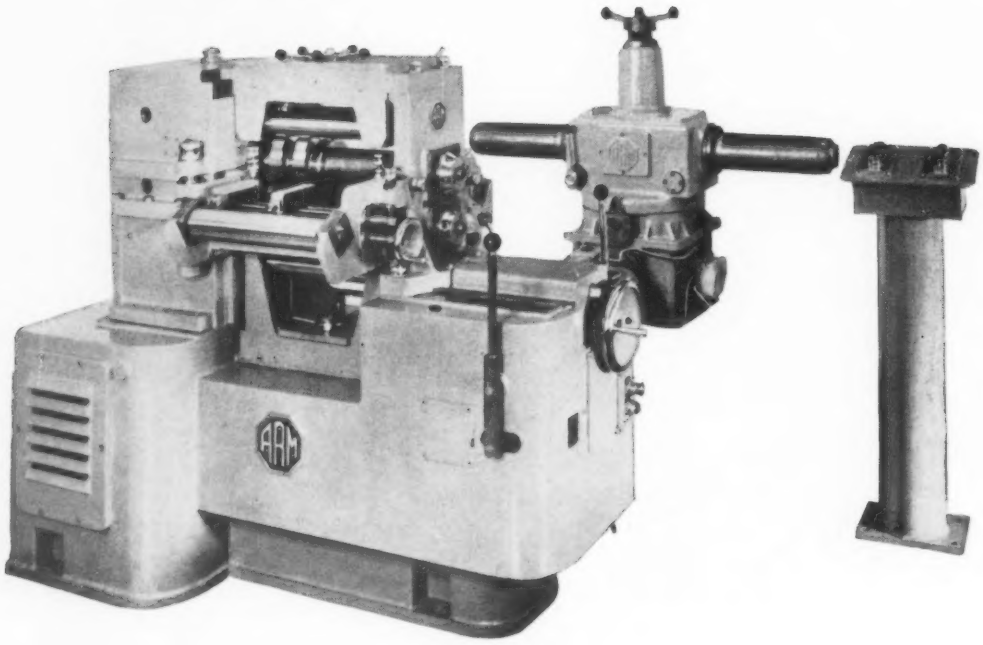

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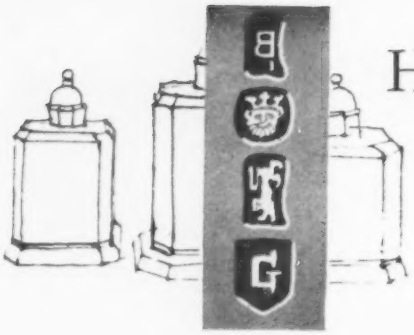

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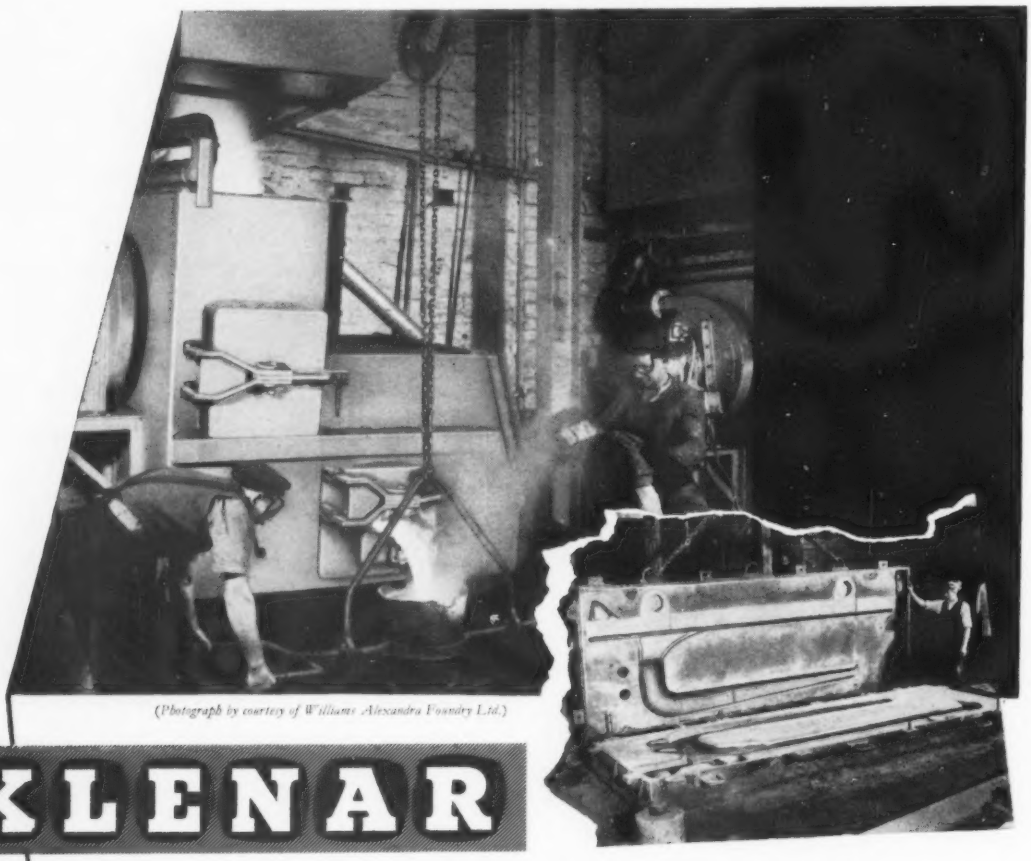

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FOUNDED 1909

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In some cases the existing procedure of a producer is accepted as the best practice of the art and is taken as a basis for the standard in question. Thus British Standard 1004 (Zinc Alloys for Die Casting) was based on the established practice of the Imperial Smelting Corporation in the production of Mazak.

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METAL INDUSTRY

VOLUME 98 NUMBER 16 21 APRIL 1961

Five Factors

REVIEWING his two years of office as President of the Federation of British Industries, Sir William McFadzean claimed that, with regard to exports, 1960 would be labelled "The Year of Exhortation". After outlining the current situation, and suggesting that we must aim at an increase of at least 10 per cent, he expressed the strong hope that 1961 would become "The Year of Action". To ensure the complete achievement of the aim means paying attention to many factors but five, in Sir William's view, are essential.

First, we must ensure that we are extremely efficient producers of the right goods at the right price and at the right time. Too little attention is still being given to the tastes and requirements of overseas customers; this is no time for the "take it or leave it" attitude we have got away with in the past. Although the position regarding delivery dates is improving, there is still room for more improvement. Particularly is this so in those cases where delivery is delayed through circumstances beyond the control of the manufacturer but where no attempt is made to warn the customer well in advance. In the second place, although there are many factors outside the control of industry which vitally affect the export performance of this country, industry itself, by putting its house in order, can do much to make the cost of British exports competitive in all markets.

However efficiently goods can be produced and transported, they must still be sold. Here we agree with Sir William that Britain has too few salesmen on the road to ensure that constant personal contact which is the essence of successful selling. Again, to be really effective overseas, salesmen should be able to speak languages, should know the feelings and appreciate the requirements and aspirations of the countries to which they are selling, and should be given maximum status. As Sir William said: "Too often in this, and possibly other countries, the belief is held that any "dogsbody" can go on the commercial side".

It is, of course, just as important to sell Britain itself as it is to sell its products. In this, the technical press, by telling the world of British achievements, in the scientific and industrial spheres, can play a leading part. Industry itself can help by providing the success stories and by not hiding its light under a bushel as unfortunately it often tends to do.

Lastly, the terms on which goods can be sold are, of course, very important, and in particular those relative to credit and credit insurance. In this connection the improvements in the Export Credit Guarantee Department's facilities recently announced by the President of the Board of Trade should be of great value. For instance, the exporter will receive full payment on completion and acceptance of his order, the buyer paying from a bank loan guaranteed by E.C.G.D. Again, all premiums have been reappraised so that in fact every general class of policy-holder will benefit. In the case of engineering goods, there will be increases in some individual rates for good markets, along with larger cuts in the premiums for weak markets, arrangements being made to ensure that no exporter is worse off during a reasonable period of transition from the old system of charging to the new. In addition, a completely new policy has been introduced specially tailored to the needs of the "small exporter"—defined as a firm whose *export* turnover is below £10,000 per annum. This new cover gives the small exporter security to venture into the export trade, with new buyers in new markets.

Out of the MELTING POT

Counting Corrosion

WHILE, elsewhere, investigation and discussion regarding the mechanism of the Kramer effect are still going on, investigators at the Odessa Technological Institute have gone ahead and investigated the possibility of using the evolution of hydrogen peroxide (to which the Russell effect—the blackening of a photographic emulsion in contact with a metal surface—is usually ascribed) for a close evaluation of the rate of atmospheric corrosion of magnesium and aluminium. Without bothering at all about the Russell effect as such, they started from the basis that hydrogen peroxide is evolved during the oxidation of a metal surface and gives rise to a latent photographic image and that this latter could be used to study the very early stages (the first fractions of a second) of the corrosion of metals by means of special emulsions sensitive to hydrogen peroxide vapour. To provide a quantitative basis for such studies, parallel experiments were made, in which the rate of atmospheric oxidation of finely finished surfaces of pure aluminium and magnesium was followed by the rate of blackening of a photographic emulsion and also by measuring the increase in thickness of the surface film using Drude's optical polarization method. The specimens were exposed at 20°C. to air having a relative humidity of 65 per cent. The rate-of-oxidation curves obtained by the photographic and the optical method showed close agreement, indicating a definite relation between the formation of molecules of the oxide of the metal and that of hydrogen peroxide molecules. A quantitative relation was established between blackening and the concentration of hydrogen peroxide and the number of molecules of hydrogen peroxide reaching the emulsion, by experiments in which the emulsion was exposed above the surface of hydrogen peroxide solutions of known concentrations. Then, taking into account the true surface area of the specimens (as derived from profilograms) it was possible to calculate that the evolution of one molecule of hydrogen peroxide corresponded to the formation of 11·5 molecules of aluminium oxide and to 27·5 molecules of magnesium oxide. This, taken together with the results of an earlier investigation which indicated a 1 : 1 relation, suggests that a considerable proportion of the hydrogen peroxide formed decomposes on the metal surface.

As Described

TIME was when chickens were fed on recognizable foodstuffs and, in the course of their wanderings about their run, were able to pick up whatever they fancied and whatever, presumably, did them good. Time also was when one of those chickens could finish up as a recognizable boiled or roast fowl on the dinner table. Nowadays, when chickens are mechanically fed on unrecognizable concentrates, what more unnatural than the next step of converting them to an equally unrecognizable (were it not for the description on the attractive label on the package) chicken concentrate to be fed further down the line on contemporary dining tables. A process of making chicken concentrate comprises cutting up the chicken on the bone into chunks, then contacting the chunks of chicken with 5 to 10 per cent by weight of phosphoric acid to disintegrate substantially completely the chicken meat and bone, and then neutralizing the phosphoric acid with at least one member of the group consisting of oxides and hydroxides of magnesium and calcium and the hydroxides of sodium, potassium and ammonium to form edible phosphate. If the resulting chicken concentrate is to be used in a chicken soup base, further departure from the original chicken becomes necessary, the recipe, or, as it is more appropriately called, the formulation (in parts by weight) comprising 25 parts chicken concentrate, 3 parts monosodium glutamate, 1·5 parts onion powder, 10 parts cornstarch, 5 parts spice mixture, 25·5 parts salt, and 30 parts dextrose.

More Than Mixing

ADDING metal powder or fibres to synthetic resins with a view to obtaining products combining the advantages of both constituents: chemical resistance, anti-friction properties, etc., on the one hand and, for example, thermal conductivity on the other, was an excellent idea many years ago. It still is, except that it is no longer novel. Variants and improvements on the original idea, for the appearance of which ample time has certainly been available, seem unfortunately to have been few and far between. Too little attention seems to have been given to the effect of particle size of the added metal powder. Little systematic study has been devoted to the variation in properties with concentration of metal powder, to the relation between the metal used and the nature of the plastics, to methods of introducing metal powder into the plastics or the possibility of forming it *in situ* by reduction of a metal compound and, last but not least, to various ways and means of treating metal-plastics mixtures. An example of what can be achieved by such ways and means is provided by a method devised for producing composite plastics-metal powder supported bearing layers. Such layers, as produced hitherto, while they had good anti-friction properties and chemical resistance, thanks to the plastics, and a reasonable thermal conductivity, thanks to the metal, had a poor resistance to impact loads, which tended to cause fairly rapid disintegration of the material. The behaviour in the latter respect of composite plastics-metal powder bearing layers can be improved appreciably by heating the layer, after it has been applied by some suitable means, to cause, first, melting of the plastics material and then melting of the metal powder. The latter may consist of cadmium-tin or lead-tin alloy or pure tin (melting points from 176° to 232°C.). During the melting of the metal powder, the plastics material acts to some extent as a flux and enables the bonding of the particles among themselves and to the surface of the support. The resistance of the bearing layer to impact loads and the strength of the bond between it and the support are thereby greatly increased. After melting of the metal powder, the temperature is lowered 10° to 20°C. below the melting point of the metal and maintained for the time required for the thermosetting of the plastics constituent of the bearing.

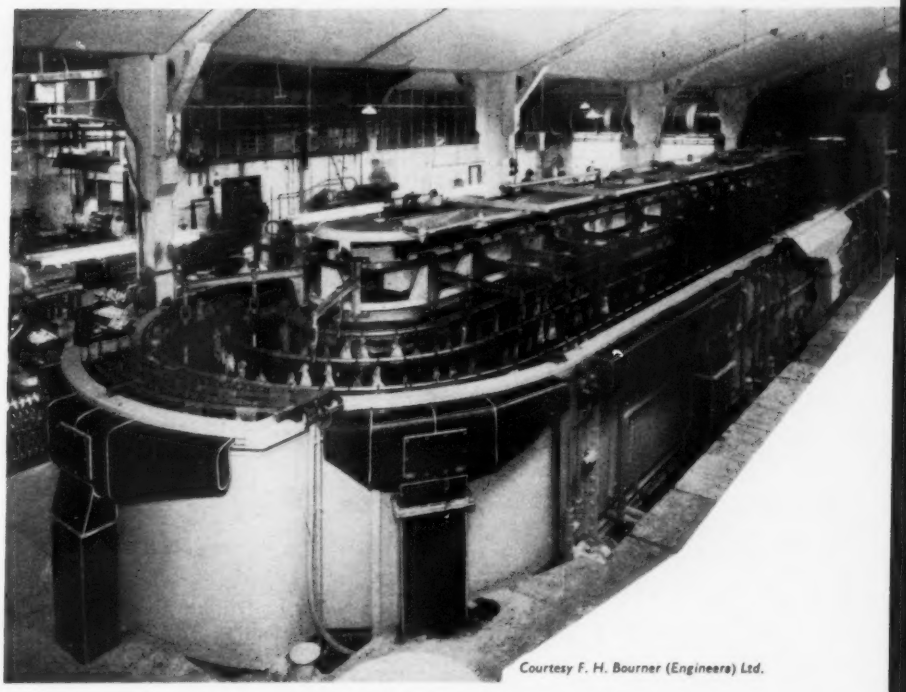
Skinner

Plating Shop Layout and Installation

By C. R. Darby

(Technical Engineer, W. Canning and Co. Ltd.)

(*Concluded from* METAL INDUSTRY, 14 *April* 1961)



Courtesy F. H. Bourner (Engineers) Ltd.

Fig. 10—Automatic plating installation, showing freedom from overhanging structures

WITH manufacturing companies there has been an increasing tendency towards obtaining a layout which, apart from meeting their production requirements, also looks attractive.

Automatic plating plants and mechanized installations do not present a problem. Services can be run alongside the equipments, either above or below ground level.

As will be seen from the general view of an automatic plating installation shown in Fig. 10, the tanks are free from any overhanging structure other than the work arms which carry the plating jigs. Gulleys are sited each side of the plant, and side ducts to exhaust the fumes have downward discharge outlets connecting into main exhaust ducts built into the floor. Pipework services and busbar can be fed to the plant at low level. The whole place can be considered as one unit and the installation planned accordingly.

Manual Plants

Manual plants with separate lines of tanks, gangways, breaks in the lines, etc., present a more difficult problem. There are, however, a number of features which can be incorporated to improve the layout and look of the shop and to assist working conditions.

Tanks should be of a standard height and width. Continuous capping can be fitted along the two longitudinal edges to finish off the top edges of the tanks and present a neat and uniform appearance.

Tubular end drip shields can be incorporated in the design of the tanks or, alternatively, plastics drip shields may be fitted after the line of tanks is in position, to prevent spillage on the floor between processes.

As an additional feature, the front of the tanks can be panelled in. An alternative method, simpler but effective, is for vertical wood packers to be positioned between the tanks so that the face of the tanks presents an unbroken line.

Interior walls of the plating shop should be tiled and an acid-resisting floor installed. Staffordshire blue bricks, paviors or quarries set in bitumen have been widely used for plating shop flooring and have given excellent service. In recent years, however, the use of bitumen has been superseded by acid-proof cement. A wide range is now available capable of withstanding fairly high temperatures, usually well in excess of those normally encountered in plating departments.

Outlet from tanks should discharge into glazed earthenware gulleys so that the floor is kept dry. The floor itself should be given a slight slope, say $\frac{1}{4}$ in/ft., towards the channel. The edges of the channel are recessed and where it is exposed the channel is covered by a grating for people to walk on.

Tanks and other equipment are best set on plinths to minimize attack on the tank bottoms, etc., and permit the floor to be hosed down periodically.

Exhaust systems should be fitted to all fuming and heated tanks, and provision should be made for replacing and heating the replacement air required.

All services exposed in the plating shop should have good resistance to corrosion. Plastics pipework can be employed for water and for air lines, and for solution circulation.

Attention should be given to the painting and the colour scheme, both for the building and for the items of equipment. An epoxy resin paint or a special acid and alkali resisting paint should be used.

Finally, the other main feature to improve the layout is the siting of the services. With a plant of any size, particularly if the heated and fuming tanks are exhausted, the final result will look like a "forest" of pipes if all services rise individually from each tank.

Various methods of overcoming this problem are available.

Siting of Services

Services can be run overhead with one set of "droppers" per line. The overhead mains and exhaust trunking can be sited on the floor above or, alternatively, fitted inside a false ceiling as an additional feature. A model of this type of installation was briefly described in the previous article.

With this particular type of layout, rectifiers and fans are usually located on the floor above. In most cases they are positioned vertically above their respective tanks, keeping the runs as short as possible.

Services can be positioned at the rear of tanks, if the line is being operated from one side only. In certain cases, pairs of lines can be positioned back-to-back and the services installed between them.

An installation of this type, with the services at the back of the two outside lines of plant and between the central pairs of rows of tanks, is shown in Fig. 11. The services are also "boxed in" as an additional feature.

This illustration also shows the use of continuous capping and the provision of services below top of tank level.

Fig. 11—Back-to-back installation, with services at the rear of the two outer lines of plant, and between the central rows [Courtesy S. Smith and Sons (England) Ltd.

In this instance, control valves are brought out to the front of the plant, all valves for a particular service being at the same height throughout the plant.

The supply mains—pipework services, busbars, electrical control wiring, fume and steam extraction—are taken into the centre of each line from a tunnel running below the floor across the centre of the shop, at right-angles to the lines of tanks.

A similar type of installation is illustrated in Fig. 12, an alternative method being employed to give the front of the tanks a "clean" appearance, the space between front corners of adjacent tanks being covered by wood packers. Control valves for services are located adjacent to the fascia panel at the rear of the tanks covering the services, and in this instance the main pipe lines, ducting and busbars to each line are fed from above.

An American plant recently installed on similar lines had a rectangular section exhaust duct built in brick between each pair of lines of tanks, and the pipework services were mounted on top of the brick duct.

Finally, services can be positioned below the working floor level, either below a steel gridway floor, or in a channel built into the floor at the back or under the tanks, or actually below the floor in an underground room or in a series of passageways. Typical examples are described below.

A gridway floor between the lines of tanks, the tanks standing on piers, is incorporated in the installation shown in Fig. 13. With this installation the service mains run under the steel flooring between the rows of tanks and have a protective plastics cover over them. The tanks are panelled in, services coming up in the space between the ends of adjacent tanks. This results in a clean appearance to the plating lines and permits working both sides of the plant.

A similar arrangement can be obtained with a tiled floor taking the place of the steel mesh floor shown in Fig. 13. In this latter case the lines of tanks are sited in channels in the floor. The ducting, busbar and pipework mains are located either below the tanks in the space between the underside of the tanks and the floor of the channel or, alternatively, at one side of the tanks in a covered trench, the top of the trench being level with the main floor.

With mechanized plants, in some instances the ducting only will be located in the covered trench, the pipework services running longitudinally down the side of the plant.

An alternative scheme for siting the main services, exhaust fans and rectifier equipment is to house them in a room below the plating shop, the busbar, ducting and pipelines feeding up through the floor. This type of layout is shown in Fig. 14.

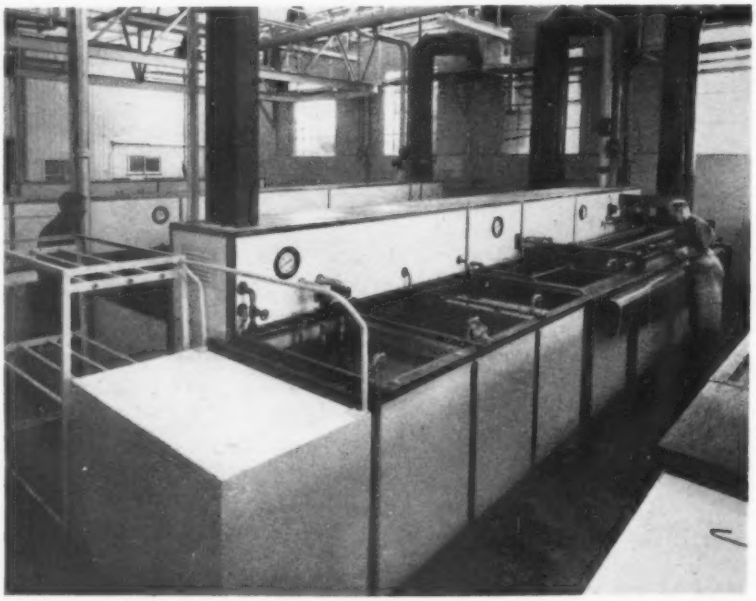
On larger installations, in place of a complete room below the floor, passageways are constructed running parallel to the lines of tanks. Busbar, services and exhaust ducting are located in these underground corridors, the rectifiers being located in a separate rectifier house, usually at ground level.

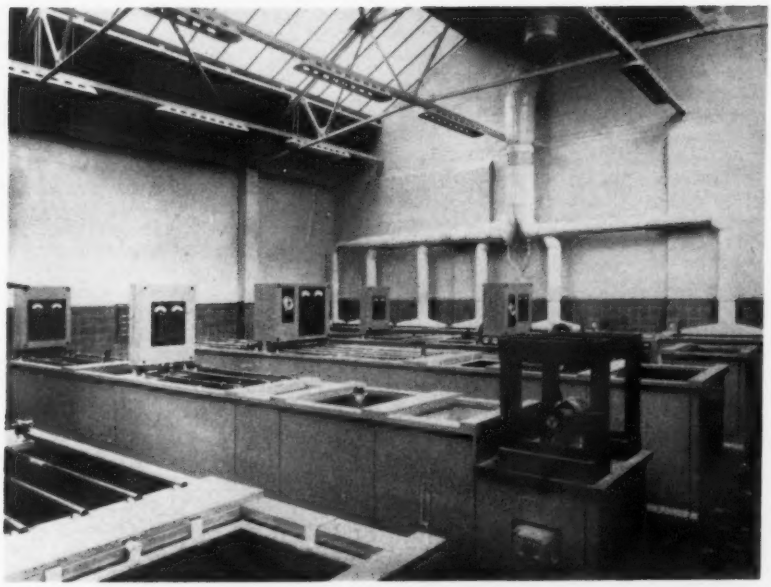
Siting of Electrical Equipment

Modern practice is for each tank to have its own rectifier set, except for small installations.

Where the rectifiers are to be sited on the same floor as the plating shop it is preferable to house them in a separate rectifier room isolated from steam and corrosive fumes. A typical rectifier installation for a manual plating plant is shown in Fig. 15. Motorized regulators for controlling the rectifier sets are available so that push-button control, indicating lights and meters only, need be sited at the plating vat, either mounted in the fascia

Fig. 12—Similar arrangement to that of Fig. 11, but with the space between adjacent tanks covered by wood packers [Courtesy Humber Ltd.





panel (if provided) or in a small meter panel or control cubicle. If the rectifier set has self contained switch control in lieu of a separate motorized regulator, the switches can be taken off the rectifier and incorporated in the small meter panel on the plating vat and interconnecting wiring provided.

In cases where one rectifier is supplying a number of process tanks, remote controlled contactor operated resistance boards can be installed. This again permits a small meter panel with switches to be installed at the plating vat position, the main resistance board being sited at a convenient point in the service run.

Depending on the layout and the relative position of the lines of process tanks to the rectifier room, controls for the rectifiers and all ancillary equipment may be located on the dividing wall between the rectifier room and the plating shop.

Ventilation

Modern practice is to exhaust all process tanks where spray or fume is involved, also heated tanks where the temperature is in excess of approximately 140°F. The extraction should operate on the vapour or spray given off as near as possible to the point of origin, and for this reason, with certain exceptions where fumes are also evolved when the work is raised clear of the process solution (e.g. bright dipping), lip type of extraction is fitted.

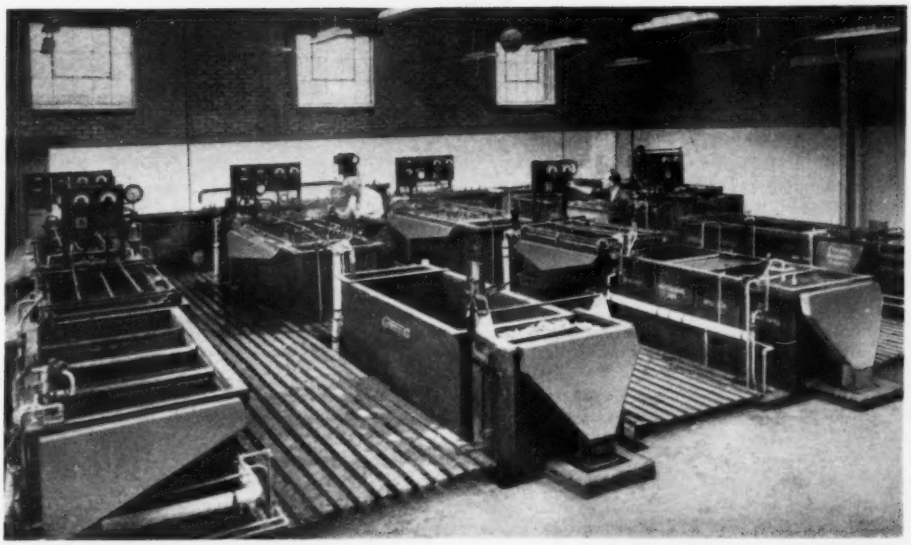
Figures for extraction rates for the ventilation of open surface tanks are published in various handbooks. If all the tanks indicated above are exhausted, this will frequently give, in practice, a ventilation rate of 20-30 air changes per hour in the plating shop.

The planning of a new plating shop, therefore, should include provision for replacing the extracted air and also for heating this replacement air.

If this is not undertaken, excessive draughts will be created at doorways

Above: Fig. 13— Panelled-in tanks with services entering in the space between the ends of adjacent tanks. A gridway floor is installed between the rows of tanks, which stand on piers.

[Courtesy English Electric Ltd.



Right: Fig. 14— Manual plant layout with main services, exhaust fans and rectifiers housed in a room below and services entering through the plating shop floor.

[Courtesy Desmo Ltd.

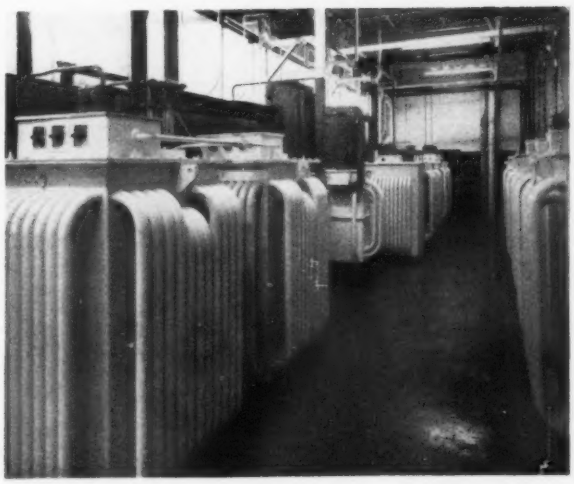


Fig. 15—Typical rectifier installation for a small plating plant

[Courtesy Humber Ltd.

and at any other points where the air can leak through from surrounding areas. Working conditions of the operators will be affected, and the efficiency of the lip extraction will be reduced.

The amount of replacement air required can be limited by utilizing a "push-pull" system. Replacement air is taken from outside the shop, blown across the surface of the tank and exhausted from the far side. This system is also employed for wide tanks. In practice, extraction is only effected over a distance of about 3 ft., so that in the case of wide tanks blowing is employed over the remainder of the distance to get the fumes adjacent to the mouth of the extraction duct.

Colour Schemes

In the comparatively few cases, in the writer's experience, where consideration has been given to the use of colour scheme in planning the plating shop, the results have been most effective. There is no reason why the plating shop should not be at least as attractive as the remainder of the factory.

If the walls are tiled, a coloured tile is preferable to plain white, which gives a drab appearance. Examples of recent installations have included in this respect, in one instance, oyster coloured tiles and, in another case, biscuit colour.

The colour scheme of the entire shop, including plant, walls and ceiling, must be considered as a whole and the colour for the process lines chosen accordingly. Lines of tanks, if not "boxed-in", can be attractively painted in bright colours. The whole plant need not necessarily be painted one colour. In one recent installation, alternate process lines were painted lighter and darker shades of the same colour, giving a pleasing effect. Busbar, electrical and pipework services should be painted to permit easy identification.

By better layouts and improved working conditions, with suitable automation or mechanized equipment to lighten the physical labour required, productivity will be increased and the right type of labour attracted.

It is interesting to note that by improved layout the efficiency of one plating department was recently increased by as much as 24 per cent.

Acknowledgment

The author expresses his thanks to the directors of W. Canning & Co. Ltd. for permission to publish this article

Men and Metals

In accordance with the new arrangement of the Morgan Crucible group of companies, the following gentlemen have been appointed managing directors of the subsidiary companies: **Mr. C. S. Harris** (Morganite Carbon), **Mr. D. S. S. Thynne** (Morganite Crucible), **Mr. I. Weston Smith** (Morganite Electroheat), **Mr. J. Walker** (Morganite Research and Development), and **Mr. J. H. Baumann** (Morganite Exports).

It is announced that **Mr. D. H. Mansfield** has been appointed to the board of General Tin Investments.

News from the British Aluminium Company Limited is that **Mr. P. J. Prior** has been appointed to the board and will be taking up his duties as financial director on May 1 next.

The Governors of Borough Polytechnic have appointed **Mr. J. C. McVeigh,** M.A., M.Sc., A.M.I.Mech.E., as Principal Lecturer in the Department of Mechanical Engineering.

A recent appointment at Armstrong Stevens and Son is that of **Mr. A. E. Clifford,** who has been made joint managing director.

In order to release **Mr. C. Pritchett** for other management duties, **Mr. Alan W. Baker** has been appointed general manager of Chloride Batteries Limited.

Deputy chairman and joint managing director of William McGeoch and Co., **Mr. W. Percy McGeoch** has been appointed President of the National Brassfoundry Association. He has served on the Council of the Association for many years.

Joint managing director of Midland Silicones, **Dr. R. A. Gregory** is resigning that position but will remain a director of the company. He has recently been appointed to a completely new position with Albright and Wilson (Mfg.) Limited. **Mr. K. A. M. Barton** is to be managing director of Midland Silicones.

As from April 5 last, **Mr. Paul Gotley** joined the board of Electrical Remote Control Company Limited.

After thirty-eight years' service with Associated Electrical Industries Ltd., **Mr. Arthur Clive Lane,** B.Sc., A.M.I.E.E., retired last week.

It is learned from Secomastic Limited that **Mr. E. L. Townsend** has been appointed chairman of the company and **Mr. C. G. Tudor Pole** is to be managing director.

At the first board meeting of CIBA United Kingdom Limited, held in London recently, **Mr. J. M. Baldock** agreed to join the board.

After 41 years' service with Associated Electrical Industries (Rugby) Limited, **Mr. H. L. Satchell,** M.B.E., F.I.W.M., has retired. He was director of manufacture.

Following the retirement of Mr. H. L. Satchell, **Mr. E. H. Cox** has been appointed director of manufacture at Associated Electrical Industries (Rugby) Limited. Mr. Cox became general manager in 1957 and joined the board of B.T.H. in 1958. He was appointed deputy director of manufacture in January 1960.

Having retired from the board of London Tin Corporation, **Mr. J. Ivan Spens** has now been appointed President.

Correspondence

Correspondence is invited on any subject considered to be of interest to the non-ferrous metal industry. The Editor accepts no responsibility either for statements made or opinions expressed by correspondents in these columns

Longer Crucible Life

SIR,—We were interested to read a short article entitled "Longer Crucible Life" in METAL INDUSTRY, April 7, 1961, page 269.

It may interest you to know that we also co-operated with J. V. Murcott & Sons Ltd. in the design of a long ingot, similar to the one that you describe, and, in fact, we were the first to supply them with bulk deliveries of aluminium alloy ingot in this form.

This new shape of ingot, we agree, has more advantages, both from the point of view of avoiding crucible breakage and providing more convenient baling, but, naturally, most ingot makers usually wish to limit the range of ingot shapes they are called upon to supply.

Our range, for example, covers most foundries' requirements and includes a large 25 lb. ingot, which is useful for bulk melting in large furnaces; the orthodox three notched type of ingot; now the 24 in. long ingot, which only has small notches near the ends to assist the furnaceman in lowering it carefully into the crucible with the aid of his ladle; and, finally, a small 2-3 lb. ingot with seven notches, suitable for very small melting units.

Yours, etc.,

C. J. Williams, A.I.M.
Sales and Technical Director,
Wigley Aluminium Limited.

DISCUSSION AT THE SPRING MEETING OF THE INSTITUTE OF METALS

Copper Alloys

BASED on the four Papers below, a discussion on "Copper Alloys" formed the programme for one of the sessions of the Institute of Metals Spring Meeting, held on Wednesday, March 22.

The four Papers under consideration were :—"Precipitation in Commercial Copper-Beryllium Alloys", by Dr. A. R. Entwisle and Mr. J. K. Wynn; "The Development of Strain Markings in Copper and Alpha-Brass: Some Effects of Deformation Temperature", by Mr. M. Hatherly; "Stress Relaxation in Copper and Alpha-Brasses at Low Temperatures", by Dr. P. Feltham; and "The Effect of Low-Temperature Annealing on the Indentation Hardness of Cold-Worked Alpha-Brass", by Mr. C. Baird and Dr. P. H. Jennings. This last Paper was presented by Dr. Hall.

The chair at this session was taken by **Dr. L. B. Pfeil,** O.B.E., F.R.S., Past-President.

DISCUSSION

Prof. J. Nutting (University of Leeds): In their Papers both Baird and Jennings and Feltham made some wrong assumptions about the shape of the dislocations in alpha-brass. The nature of this assumption affects the kind of argument that one could use to account for the phenomenon which they have observed.

Swan and Howie, at Cambridge, have determined the stacking fault energy of copper-based alloys as a function of composition. To put it in an electron atom ratio, starting off with copper, there is a stacking fault energy, which we can guess, at about 50 ergs. As the amount of alloying element is increased—in this case zinc—the stacking fault energy falls so that at a 70 : 30 composition, the stacking fault energy has a value somewhere of the order of 10 ergs. This means that in these materials the dislocations will be quite widely dissociated under normal conditions and we shall have, not a simple

M. Hatherly

P. Feltham

Precipitation in Commercial Copper-Beryllium Alloys

By A. R. ENTWISLE, M.A., Ph.D., and J. K. WYNN, M.Met.

FOUR commercial copper-2 per cent beryllium alloys were studied to determine the type of precipitate occurring in the range 300°-500°C. It was concluded that below 380°C. typical age-hardening processes occur, between 380°C. and 500°C. precipitation mainly occurs as a lamellar "pearlitic" structure nucleated at grain boundaries, and above 500°C. a rather coarse precipitate of isolated particles forms. Transformation curves are C-shaped, and are displaced to shorter times and higher temperatures by increased beryllium content, and to longer times by increasing the grain size.

Cold work after quenching tends to suppress the lamellar precipitate during ageing and to favour general precipitation. The hardenability of the alloys investigated is sufficient to prevent the formation of the lamellar precipitate during an efficient quench. Any interruption of the quench in the critical range of temperature (400°-500°C.) produces detectable grain-boundary precipitation. If the lamellar precipitate is present in material given the normal commercial ageing treatments, the strength is lowered and the ductility increased in proportion to the amount of lamellar precipitate. The effect is less noticeable in cold-worked material.

The Development of Strain Markings in Copper and Alpha-Brass

By M. HATHERLY, M.Sc., A.S.T.C., F.I.M.

IT has been established that the microstructure of deformed α-brass depends on both the deformation temperature and the zinc content. Strain markings, similar to "slip band indications", are developed in high-purity copper after deformation at low temperatures, and increases in deformation temperature also increase the strain at which markings first appear, at the same time decreasing both the number of grains in which they are found and the number of markings in any one grain. The markings become broader until, apparently, they attain a maximum width between −183°C. and −76°C. However, the markings are not found after deformation at higher temperature.

This general pattern is followed in the copper-zinc alloys. Increase in zinc content increases the temperature at which markings attain the maximum width and above which they are no longer observed. In 70 : 30 brass, this temperature is > 800°C. At the upper limit of the temperature range at which markings are developed, they appear as wide clustered areas, lenticular in shape.

The origin of the markings has been variously explained, but the regular relationship between zinc content, deformation temperature and microstructure is, in some respects, consistent with the development of stacking faults in the alloys. It may also be interpreted as providing evidence for the existence of mechanical twinning as a deformation mechanism in face-centred cubic metals. The results indicate that previous experiments do not necessarily preclude this possibility.

Stress Relaxation in Copper and Alpha-Brasses at Low Temperature

By P. FELTHAM, D.Sc., F.Inst.P.

RELAXATION in the range 77°-291°K of the applied tensile stress σ at constant strains of up to 1 per cent has been studied in polycrystalline copper (99·99 and 99·999 per cent) and α-brasses (10-35 per cent zinc), vacuum-annealed at 800°C. to a grain size of $4{\cdot}5 \times 10^{-3}$ cm. The stress relaxed from the initial value σ_0 to a final value σ_r, generally within ½ h; the logarithmic law $\sigma_0 - \sigma = s \log_{10}(1 + \nu t)$, with ν of the order of 10/min., described the relaxation well over most of this period. The slope of the curve, given to a good approximation by $s = -d\sigma/d(\log_{10} t)$, had a maximum at any given temperature in the range of compositions close to Cu.Zn. This is ascribed to local ordering near jogs, which results in a lowering of their misfit energy and hence facilitates the migration of dislocations. The relaxation appears to result from a limited continuation of glide initiated on yielding, and the observations are consistent with a model in which the drag of conservatively moving jogs in edge dislocations is rate-determining. The model accounts satisfactorily for the marked increase in s with decreasing temperature, as well as for the logarithmic form of the relaxation.

C. Baird

P. H. Jennings

dislocation, but the partials, with quite a wide stacking fault in between them.

Swan then determined the stacking fault energy of copper-aluminium alloys as a function of temperature. It can be assumed that the arguments are roughly the same as working with an alpha material. This starts with a stacking fault energy considerably lower, of the order of 5 ergs. He found that as the temperature was increased, the stacking fault energy remained roughly constant, until temperatures of the order of 250°-300°C. were reached, when the stacking fault energy started to increase. That means that these partial dislocations will come closer together.

If these dissociated dislocations are examined, using thin foil techniques, one sees a picture in which essentially we have the two partial dislocations with the normal kind of stacking fault contrast in the form of bands. Superimposed upon this were very fine striations running parallel to the partial dislocations. This can now be interpreted as forming a Murray pattern between the partial dislocation, the Murray pattern produced, possibly, by a change of lattice parameter in the region of the stacking fault.

Swan interpreted these results by saying that the change of lattice parameter came about by segregation of solute elements to the stacking fault.

Whilst these results were obtained on copper-aluminium, the same argument would apply to the copper-zinc materials. That is, one gets atmosphere locking in the dislocations in alpha-brass. Therefore, since there is experimental evidence which tends to suggest this, I would tend to favour the other explanation which Baird and Jennings gave for their hardening: that is to say, it can be looked upon as a kind of strain ageing effect that will deform the material. One then gets segregation of solute elements to these dissociated dislocations.

That leads to atmosphere locking of the dislocations. At higher temperatures this dislocation atmosphere can be boiled off. So the dislocations associate and, therefore, there is a lowering of the yield stress. Once the dislocations have dissociated, one would expect them to deform somewhat more readily. So that I would tend to favour the mechanism which Baird and Jennings put in as a footnote to their Paper and dismissed in favour of their internal strain. But whatever the arguments used, one must bear in mind that the dislocations in alpha-brass are very widely dissociated and that there is the possibility of forming these dislocation atmospheres.

A somewhat similar argument could be applied to some of the results which Dr. Feltham obtained. He suggests that the dislocations are pinned here at jogs and the relaxation process means that this could change to another set of pinning points. Again, he draws the dislocations as lines. This is a very dangerous thing to do in the case of alpha-brass, because the dislocations are not lines; they are ribbons. One is bound to get unusual effects if one starts deforming these materials and getting Z-locking at the dislocation. This will tend to lead to peculiar relaxation effects if it is possible for the atmosphere to be displaced or dispersed as a result of any thermal activation process. This could tend to modify to some extent the arguments which Dr. Feltham used.

Baird and Jennings argue that the Z-locking kind of mechanism could not apply because they feel that there is no very marked yield point in alpha-brass. I do not think that it is essential to have a sharp yield point in the material to get this Z-locking effect. I do not think that this is a consequence. It is just a general raising of the yield stress or the flow stress, because the separation of these particles is relatively large and it is not a case that one gets in alpha-iron, where there is a relatively narrow dislocation and one can imagine it being pulled away from its pinning points or from its atmosphere fairly readily.

Entwisle and Wynn state that precipitation in commercial copper-beryllium alloys can take place in three different ways, depending on the temperature, and that typical age hardening processes occur. Their experimental results do not prove conclusively that it is a typical age hardening process.

There is the possibility of a shear transformation taking place and the possibility of an ordering reaction. Every possible mechanism of hardening has been applied to copper-beryllium. Perhaps the authors can give further reasons why they consider the hardening typical. Admittedly, it shows an increase in hardness which is typical. One gets an increase in hardness if one ages it, but why does one get the increase in hardness?

Dr. B. H. C. Waters (Telcon Metals Ltd., Crawley): In the commercial production of beryllium-copper alloys, the solution annealing and quenching plant has been the subject of considerable and close attention in design, the object being to avoid any form of interrupted quench which commercially, practically, is certainly associated with the degradation of characteristics. However, so far as we are aware, prior to this work no systematic research had been carried out on this interrupted quench type of approach, and the work reported in the Paper by Entwisle and Wynn, therefore, fills a gap in our knowledge from the viewpoint of commercial production of this material. The work pinpoints lamellar precipitation as occurring in a quench interrupted in the range between 500°C. and 350°C., and commercial equipment has had to be designed to avoid a delay in quenching occurring in this temperature range.

The work summarized in the ageing curves presented by the authors is of considerable interest, covering as it does the generally accepted temperature levels used in practice—namely, the temperature range from 315°C. to 350°C. It is known that with lower ageing temperatures than 315°C., trouble may be experienced in achieving satisfactory hardness due to inadequate incipient precipitation occurring. The standard commercial minimum hardness is set at 350 V.P.N. in the aged condition. Fig. 10 shows that a combination of satisfactory annealing and quenching, avoiding heavy grain boundary precipitation, can be obtained by ageing at 325°C., although it shows that even with an interrupted quench, if this is followed by very heavy cold working beyond the normal run-of-the-mill industrial cold working, 70 per cent gives a minimum of 350 V.P.N.

The upper limit of the ageing heat-treatment temperature range is set by the formation of the lamellar type precipitation. This has the disadvantage, first, of reducing the hardness, and secondly, the possibility arises of rather poor elastic properties and of elastic drift. This restriction of the upper limit of the ageing heat-treatment temperature is, of course, of considerable practical importance.

The question of cold work promoting general precipitation and reducing the amount of lamellar precipitation is noteworthy and, at least from a micrographic point of view, may well mask the effects of an interrupted quench but, of course, still gives rise to degradation of mechanical properties and performance.

The work shows the importance of controlled operations in the production

Effect of Low-Temperature Annealing on the Indentation Hardness of Cold-Worked Alpha-Brass

By C. BAIRD, A.I.M., and P. H. JENNINGS, Ph.D., A.I.M., A.M.I.M.M.

TWO alternative hypotheses were examined for explaining the hardening revealed in indentation hardness tests on certain cold-worked metals after low-temperature annealing. The investigation led to the conclusion that the hardening that occurs when cold-rolled 70:30 brass is annealed at low temperatures can be satisfactorily accounted for by the hypothesis that it is due to stress relief.

Slight plastic extension by a tensile force gives an increase in hardness which, though smaller than that produced by low-temperature annealing, is well in excess of any increase that could be attributed to strain-hardening. This is consistent with the fact that plastic extension relieves only a proportion of the internal stress.

Stress relief by plastic extension followed by low-temperature annealing gives the same total increase in hardness as is given by annealing alone. This is consistent with the stress-relief hypothesis but not with the alternative hypothesis of strain-ageing.

of beryllium-copper alloys. In particular, attention is drawn to the effect of cobalt beryllides impoverishing the matrix of beryllium, and to controlled foundry, hot working, cold working and intermediate annealing processes to achieve uniform fine grain size, etc.; and this is substantiated by conventional micrography, electron micrography and other modern techniques.

We would, however, draw the attention of the authors to the use of sub-critical annealing to give a fine distribution of gamma phase in an alpha matrix, which can then be cold worked to tensiles comparable to those which can be achieved by solution annealing, quenching, drawing and ageing. This procedure offers many advantages and avoids many difficulties.

Dr. Cahn (Birmingham University): Evidence obtained in Birmingham tends to bear out the interpretation which Prof. Nutting has put forward concerning anneal hardening. This work was done on copper-aluminium alloy to check the hypothesis that annealing hardening effect is connected with the process of short range order which can be destroyed by the strain of cold work of rolling and then brought back by the low temperature anneal.

To check such a hypothesis, a solid solution in which there are substantially different atomic weights must be used, so that X-ray tests can be done. As Prof. Nutting pointed out, however, any results obtained on aluminium-bronze would be likely to be applicable to brass, because the substances are very similar.

The work was in two halves. One half was a study of mechanical behaviour and the other half was X-ray study, in which an attempt was made to get direct X-ray evidence for the existence of segregation of solute of aluminium to the stacking fault in the dissociated dislocations by looking for an increase in the small angle scattering of X-rays, with precautions to exclude possibly false interpretations. This work gave some quite convincing evidence that there is indeed segregation of aluminium to the stacking fault when this alloy, after cold work, is annealed at near 200°C. The detail of isothermal hardening is as for rolled hardness; it is about 230°C. So there are increases in hardness of something like 15 per cent. The maximum hardness appears to be substantially independent of the annealing temperature, only the time required to get there differs from one temperature to another. At the higher temperature there is a maximum, and then a drop because the material begins to crystallize.

A long-time test at lower temperatures, from 150°C., again showed a tendency to approach hardness increases of 30 points. The tendency was that the capacity for annealing hardening was pronounced only in the most concentrated alloys. With 10 at. per cent, the effect is much less pronounced. In pure copper, it is not present at all. If the interpretation of Jennings and Baird in terms of the release of internal stresses is correct, it is necessary to explain why pure copper does not behave like this.

In experiments on strain ageing of polycrystals after tensile stresses, the situation turned out to be more complicated. Work on the strain ageing of single crystals of copper-aluminium has shown strong evidence of anneal hardening and the formation of yield points. In these duplicate specimens, a short-term strain ageing gives a natural softening, and longer anneal hardening gives a positive increase of flow stress.

Work-hardening tests show that after small pre-strains there is actually a softening, whereas after larger pre-strains there is hardening, but it is still less than the hardening that is obtained after rolling. Altogether, the hardness test is rather disconcerting and inclined to give misleading results.

For a standard pre-strain, the amount of change of flow stress which results from annealing depends on the temperature. At low temperatures, one gets recovery. At higher temperature, one gets anneal hardening. One can get either a softening or a hardening, depending on (a) the magnitude of the pre-strain and (b) the temperature concerned.

Data obtained by taking three specimens, giving tensile extensions of 10, 20 and 30 per cent, respectively, and then various types of anneal at a temperature of 200°C showed that the greater the pre-strength, the greater the increase of hardness which results. Anneal hardening was measured by making hardness impressions on the flat tensile surface. If one normalizes these results by expressing them as hardness increase as a fraction of work hardening, all the results that follow must occur. At the bottom of the curves, a 10 per cent extension shows quite unmistakably anneal hardening, whereas when measuring the consequence of anneal hardening, in relation to its effect on flow stress, things are the other way round. After 10 per cent stress, it increases and then recovers. This is, perhaps, not altogether surprising because, anything else apart, a hardness test is determined by a complex of the flow stress and the work hardening capacity.

The effect is not restricted to copper-aluminium, as the authors have said. In a test on a copper-germanium alloy with even more dissociated dislocations than copper-aluminium, the effect is smaller. If the hypothesis that anneal hardening is due to segregation of solute to stacking fault is true, then the more dissociated that the dislocations are, the more anneal hardening there should be. But, quite plainly, any such view is not justified.

The anneal hardening effect has only been found in those alloys in which the dislocations are substantially dissociated.

If the order hypothesis is correct—that is to say, if the anneal hardening is due to the restoration of shorter order, which we prove to exist in this material (we also showed that it is a function of temperature of annealing) — one would expect the following. If one quenches copper-aluminium alloy from a high temperature without any pre-strain and gives it a 200°C. anneal, the material should become harder because the quenching from high temperature quenches out this order and the heat-treatment puts order in. But we were not able to find any trace of anneal hardening under these conditions.

G. B. Brook (Fulmer Research Institute): There are two possible mechanisms by which cobalt suppresses the precipitation in copper-beryllium. One is that cobalt may preferentially nucleate one of the structures, which give rise to the lower temperature precipitation to such an extent that the saturation increases sufficiently to prevent the structure forming. The other is that cobalt and beryllium segregate differentially at the grain boundaries and in some way interfere with the nucleation of the beryllium-rich phase in the structure.

Some time ago, we looked at the effect of antimony and various elements on precipitation in copper-based alloys. In these, we found that something like 0·08 per cent antimony had exactly the same effect in copper-beryllium as these rather high percentages of cobalt. In fact, antimony was effective in a whole range of copper-based alloys.

In that connection, it has been found that antimony preferentially segregates to grain boundaries in alpha-brasses. This suggests that this might be occurring in the other copper-based alloys which we examined.

Mr. Worthington (Sheffield University): Talking about strain ageing, Baird and Jennings say that the hypothesis is not favoured because alpha-brass does not possess a sharp yield point. This is not correct, because it does possess a sharp yield point if it is tested in the right way. If long, thin specimens are used, a reasonably pronounced yield point is obtained.

Prof. Nutting: Whilst I am convinced that it is a strain ageing effect occurring in the brass, is not one of the difficulties that of accounting for the temperature at which the strain ageing occurs? We are getting strain ageing at room temperature, almost certainly at 200°C. It seems difficult to imagine that if one is getting formation of atmospheres, we are getting the diffusion of zinc to form these atmospheres in the brasses or aluminium bronzes at low temperatures in relation to what one normally thinks of as the temperature at which diffusion could take place in such a system.

AUTHORS' REPLIES

J. K. Wynn: In reply, first, to Prof. Nutting, I think that our meaning as written in the Paper is rather ambiguous. I know that the age hardening process in beryllium-copper is rather complex. What we meant was that the reaction going on there was a precipitation hardening process as against another process.

In reply to Dr. Waters, we have not done any sub-critical annealing followed by working to strain hardness.

Dr. P. Feltham: We were not unaware of the splitting of the dislocations in the brasses; in fact, in dealing with the model, we say in Fig. 4 that for the present purpose it is sufficient to regard the dislocations as undissociated. The reason why we did not consider it dissociated to begin with was because at that stage of the development of the theory, we did not want to complicate matters too much. We were hoping that if the assumption was not right, it would show up. I believe that it does show up, because if you want to correlate results correctly, you have to make this assumption in the diagram which brings in the stacking fault.

Dr. Hall: In reply to Prof. Nutting concerning the annealing temperatures, the maximum values were given as 200°C., which does not quite come to the minimum of the curve he drew on the blackboard. I feel that his arguments would have been even stronger had these results been shown at higher annealing temperatures.

Secondly, the factor that convinced me in this work, in spite of the interesting evidence put forward by Worthington, is that by a method of both plastic deformation followed by annealing, and by annealing, the points lie on the same curve. I know of no work which shows this sort of effect in pure copper.

With regard to Prof. Nutting's remarks, I have to admit that although I have no

(*Concluded on page* 320)

Atomic Progress

Plastic Deformation of Uranium

IN 1955, Cottrell predicted that thermal cycling or irradiation would reduce the strength of alpha-uranium due to the generation of internal stresses. Within a year, experimental confirmation was obtained for the case of irradiation. Since then, a considerable out-of-pile test programme has been mounted to determine the effects of thermal cycling. Some of the theoretical and experimental work involved has been described by Young, Gardiner and Rotsey[1]. This work and its application in nuclear reactors forms the basis of this article. These workers first of all obtained standard creep data, paying particular attention to thermal fluctuations because of the possible effects on the creep rates. The temperature in the tests varied ±0·1°C. as a short term ripple (10 min. duration) and had a drift of less than +0·4°C. over about 12 hr.

Creep Law

The experimental data was shown to fit a law of the form

$$\dot{\epsilon}=\sigma^n \exp(k-Q/RT)$$

If $\dot{\epsilon}$ is in h^{-1}, σ in lb/in^2, and T in °K, the best set of constants in the equation are:

$n=2{\cdot}41$; $Q/R=2{\cdot}48\times10^4$; $k=+2{\cdot}39$

A statistical examination of the data showed no justification for supposing n to vary with temperature in the range 450° to 650°C.

The effect of a thermal cycle on the creep rate is to produce a transient acceleration, after which the original secondary creep rate is re-established. The magnitude of the acceleration increases with the amplitude of the thermal cycle. Increasing the number of cycles only slightly increases the plastic strain, for example, at 500°C. and 1,120 lb/in^2, twelve successive −20°C. cycles are required to double the strain imparted by the first cycle.

Theory

The experimental data indicate that, above a certain amplitude, thermal cycles produce plastic strain. Using an idealized stress-strain diagram, Young and his co-workers deduce an empirical equation for this temperature amplitude, $\triangle T_P$

$$\triangle T_P=\frac{Y(1-V)}{E.\triangle\alpha}$$

where Y = yield stress in tension
V = Poisson's ratio
E = Young's Modulus
$\triangle\alpha=\alpha_a-\alpha_b$, i.e. difference in coefficients of thermal expansion in the $a+b$ directions.

The plastic deformation produced by such a cycle can be determined using the Levy-Mises equations. Young *et al* give two equations for the plastic strain in the direction of the applied load. The first equation applies when the amplitude of the thermal cycle is between $\triangle T_P$ and $2\triangle T_P$ and is:

$$\epsilon=\frac{2}{3}\frac{S\triangle\alpha}{Y}\quad(\triangle T-\triangle T_P)$$

where S = uniaxial stress
$\triangle T$ = amplitude of thermal cycle

If the amplitude exceeds $2\triangle T_P$ the microscopic strain is given by:

$$\epsilon=\frac{4}{3}\frac{S\triangle\alpha}{Y}(\triangle T-\frac{3}{2}\triangle T_P)$$

Developing the analysis further, Young *et al* obtain a magnification factor, R, for the effect of successive cycles on the creep rate which has the value:

$$R=\left[\frac{E\triangle\alpha\triangle T}{S(1+V)}\right]^{n-1}$$

Agreement between the calculated temperature cycle required to produce plastic strain and experiment is good between 300° and 450°C. provided the applied stress is small in relation to the yield stress. At 500°C. the observed amplitude of cycle is much smaller than the calculated value — this discrepancy is attributed to the effect of strain rate on the yield stress at this temperature.

The plastic strain produced by a thermal cycle can be split into "immediate" and "recovery" strains. The equations quoted in the article can be used to predict the "immediate" strain. Young *et al* also derive an equation which can be used to calculate the maximum "recovery" strain. Comparison of calculated and experimental values shows good agreement for stresses less than half the yield stress. At 500°C. it is necessary to determine the value to be taken for the yield stress from a strain simulation experiment of the particular temperature cycle. The fact that the strain produced by successive cycles is not much greater than that produced in the first cycle is due to the combined effects of residual stresses and strain hardening.

The theoretical model developed by these workers gives a good representation of the effect of thermal cycles on the deformation of α-uranium. Above 450°C., where creep during the cycle becomes important, it is necessary to use a modified value for the yield stress. The effect of creep during the cycle is to cause a marked drop in amplitude of cycle which the uranium can sustain elastically. At 450°C., the limiting amplitude is ±51°C. and at 500°C. only ±9°C.

Application

With the modification to allow for creep at the higher temperatures, this theory predicts reasonably accurate values for the "intermediate" and maximum "recovery" strains, provided the applied stress is less than half the effective yield stress. This is not a restrictive limitation in practice as the loads carried by the fuel in uranium-magnox reactors of current design are quite small.

For small cycles, similar amounts of strain are produced in both the heating and cooling parts of the cycle. However, as the magnitude of the cycle increases more strain is produced on heating than in cooling due to changes in Young's Modulus, yield stress and the difference ($\triangle\alpha$) between coefficients of thermal expansion. This can be allowed for by using average values in calculations of the "immediate" strain; recovery strains should not be affected by the sign of the cycle as it is the values of $\triangle\alpha$, E and Y at the steady state temperature which matter.

The type of cycle considered by Young *et al* is typical of those found in reactor service due to trips, shutdowns and control-rod trimming. The refuelling operation, which entails repeated insertion of a grabber in a channel in quick succession, causes thermal cycles in adjacent channels. This work has shown that the strain produced will be scarcely affected by the repetitive nature of the operation.

Small amplitude continuous cycles may arise from such causes as "dead band" in the control system, and their effect is to accelerate the isothermal creep rate. Quite large effects are possible, for example, at 500°C. and 1,120 lb/in^2 stress the creep rate is accelerated by a factor of 4·5 when there is a continuous ±5°C. cycle at a frequency which maintains low magnitude internal stresses. This phenomenon is different to the yielding of the aggregate due to large cycles as discussed in this article and the strain produced by such large cycles is not expected to be affected by a background of small continuous cycles.

Other factors, e.g. irradiation growth, swelling of uranium at high temperatures, contribute to the overall distortion of alpha-uranium during irradiation. The work of Young *et al* is a further step in enabling fuel element designers to calculate the overall distortions to be accommodated.

Reference

[1] A. G. Young, K. M. Gardiner, W. B. Rotsey; *Journal of Nuclear Materials*, 1960, **2**, (3), 234.

RAPID DETERMINATION OF ALUMINIUM, IRON, COPPER, CADMIUM AND LEAD

Analysis of Zinc Alloys

By R. J. GAJAN and D. M. GEEHAN

As part of its research programme on secondary metal refining, the U.S. Federal Bureau of Mines has developed a fast method for determining aluminium, iron, copper, cadmium and lead in zinc alloys. The method is intended for use by trained technicians with inexpensive equipment. It can be used either in the analytical laboratories of the many small plants characteristic of the secondary metals industry or in laboratories engaged in basic research to improve refining processes. A complete analysis for the foregoing elements can be made in less than 3 hr. from a single sample in solution. The method is especially helpful when only small samples are available. Aluminium and iron are determined spectrophotometrically and the other elements polarographically. Results compare favourably with spectrographic methods.

FOR the determination of aluminium in zinc die-casting alloys Luke and Braun[1] described a photometric method in which the aluminium was complexed with Aluminon reagent (ammonium salt of aurintricarboxylic acid), forming a red lake. An adaptation of this method was used for determining aluminium. Beers law is obeyed between 0·01 and 0·06 mgm. of aluminium.

Margerum and Banks[2] described a spectrophotometric method for determining iron by using O-phenanthroline to form the coloured ferrous complex. This method was adapted for the iron determination. Copper, cadmium, and lead were determined polarographically.

Apparatus and Reagents

Spectrophotometric measurements were made with a Beckman DU spectrophotometer. Polarographic analyses were made with a Sargent XXI polarograph. All *p*H measurements were made on a Beckman zeromatic *p*H meter. The reaction cell for polarographic analyses was a modified Heyrovsky cell (Fig. 1) with an internal electrode of 18-gauge silver wire. Controlled potential analyses were made with a Fisher controlled potential electroanalyser.

The reagents and solutions were: hydrochloric acid, ACS grade, specific gravity 1·19; nitric acid, ACS grade, specific gravity 1·42; gelatin USP (0·25 per cent solution). Make gelatin solution daily by adding 100 mL. of boiling water to 0·25 gm. of gelatin; ortho-phenanthroline, Fisher certified reagent P-70. Make 0·1 per cent aqueous solution; ethanol; benzoic acid, reagent grade; acetic acid, glacial, ACS grade, specific gravity 1·05; hydroxylamine hydrochloride, reagent grade, 10 per cent aqueous solution; ammonium chloride, 4-mole solution; Aluminon reagent (aurintricarboxylic acid ammonium salt, Eastman yellow label P4468).

Preparation of Aluminon reagent solution: To 500 mL. of distilled water in a 2 L. beaker, add 450 gm of ammonium acetate. Add 80 mL. of glacial acetic acid to the solution and stir to dissolve. Dissolve 1 gm. of Aluminon reagent (Eastman P4468) in 50 mL. of water and add to the solution. Dissolve 2 gm. of benzoic acid in 20 mL. of ethanol or methanol and add to the solution. Dilute to 2 L. Add 10 gm. of gelatin to 250 mL. of distilled water and place in a boiling-water bath until the gelatin is dissolved. Mix well and dilute to 1 L. Add this to the Aluminon reagent solution, mix well, and store in a brown bottle.

Analytical Procedures

For the preparation of the sample solution, transfer a 1-5 gm. sample to a 250 mL. beaker and add 15 mL. of hydrochloric acid (specific gravity 1·19) drop by drop until the reaction ceases. Add the remaining hydrochloric acid and 1 mL. of nitric acid (specific gravity 1·42). Evaporate to about 2 mL. Transfer to a 100 mL. volumetric flask and dilute to 100 mL. with distilled water.

Aluminium Determination — For a sample containing 0-1·0 per cent aluminium: Take a 10 mL. aliquot of the sample solution and dilute to 100 mL.

For a sample containing 1·0-10 per cent aluminium: Take a 10 mL. aliquot of the sample solution and dilute to 1 L.

Transfer a 10 mL. aliquot of the diluted solution to a 100 mL. volumetric flask and add 15 mL. of Aluminon reagent solution. Mix and place in a boiling-water bath for exactly 5 min. Cool, dilute to 100 mL., and measure the absorbence with a spectrophotometer at 525 millimicrons, using distilled water as a reference solution.

Prepare standard reference curve as follows: Transfer aliquots of 0, 1, 2, 3, 4, 5, and 6 mL. of a standard aluminium solution (0·01 mgm/mL.) to 100 mL. volumetric flasks and dilute each to 10 mL. with distilled water. Add 15 mL. of the Aluminon reagent to each flask, set them in a boiling-water bath for exactly 5 min., cool, and dilute to 100 mL. Measure the absorbence at 525 millimicrons. Plot the corrected absorbence (total absorbence minus absorbence of the blank) versus mgm. of aluminium in the solution on rectangular graph paper.

Iron Determination — Transfer a 10 mL. aliquot of the sample solution to a 150 mL. beaker and add, in the following order: 10 mL. of a 10 per cent hydroxylamine hydrochloride solution, 30 mL. of a 4-mole ammonium chloride solution, and 20 mL. of a 0·1 per cent ortho-phenanthroline solution. Adjust the *p*H to 5-5·5 with a *p*H meter, using either ammonium hydroxide or hydrochloric acid. If a precipitate forms, filter the solution, catching the filtrate and washings in a 100 mL. volumetric flask and dilute to 100 mL. If no precipitate is observed, transfer the solution to a 100 mL. volumetric flask and dilute to 100 mL. Prepare a blank solution of the reagents. Measure the absorbence at 508 millimicrons with a spectrophotometer, and subtract the value obtained for the blank from that obtained for a sample. Water is used as a reference solution. Prepare a standard iron curve by treating aliquots of a standard iron solution (0·01 mgm/mL.) exactly as described. Plot the corrected absorbence versus mgm. of iron on rectangular graph paper.

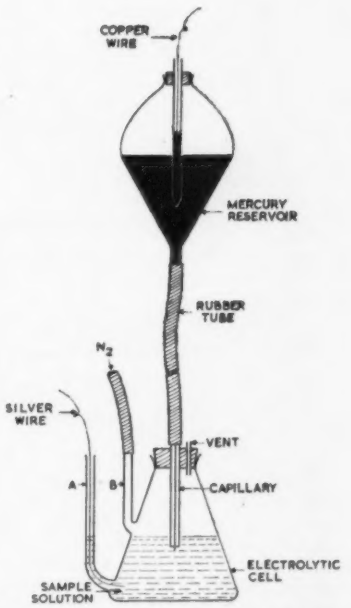


Fig. 1—Arrangement of electrolytic cell. When nitrogen is being bubbled the line is connected to A. When the polarogram is being run, the nitrogen line is connected to B and silver wire placed in A

Copper, Cadmium, and Lead Determination — Transfer a 50 mL. aliquot of the sample solution to a 100 mL. volumetric flask containing 2 mL. of 0·25 per cent gelatin solution. Add 5 mL. of 10 per cent hydroxylamine and dilute to 100 mL. with distilled water. Bubble nitrogen through 10 mL.

of the solution for 10 min. and polarograph. Compare the wave heights with those obtained from a standard solution.

Preparation of standard solution: Transfer a known amount of copper, cadmium and lead, roughly equivalent to the amounts present in the samples, to a 100 mL. volumetric flask. Add 5 mL. of 10 per cent hydroxylamine hydrochloride solution and 2 mL. of 0·25 per cent gelatin solution, and dilute to 100 mL. with 1 normal hydrochloric acid solution. Bubble nitrogen through a 10 mL. aliquot for 10 min. and polarograph. Run part of the standard solution along with each subsequent analysis. Calculation of results:

$$A = \text{mgm. component/mm.} = \frac{\text{wave height (in mm.)}}{\text{mgm. component in standard solution}}$$

$$B = \text{mgm. of component per sample solution} = A \times \text{wave height}$$

$$\text{Per cent component} = \frac{B \times \text{dilution factor} \times 100}{\text{Weight of sample (in mgm.)}}$$

The following procedures may be used if the copper content is high compared with the lead and cadmium content:

Procedure A: To 50 mL. aliquot add a known amount of lead and cadmium equal approximately to the copper content and determine the total lead, cadmium, and copper contents polarographically. Subtract the amount of lead and cadmium added from the total amounts calculated from the polarographic curves. The difference is equal to the amount of lead and cadmium present.

Procedure B: If a controlled potential electroanalyser is available, the following method may be used: Transfer a 50 mL. aliquot of the sample solution to a 250 mL. volumetric flask, add 2 mL. of 0·5 per cent gelatin solution and 2 gm. of hydrazine hydrochloride, and dilute to 250 mL. Transfer to a 300 mL. electrolytic cell and electrolyze at a potential of 0·34 V, using platinum electrodes. Weigh the amount of copper deposited on the cathode, and calculate the amount present in the sample.

Transfer a 10 mL. aliquot of the electrolytic solution to a polarographic cell, bubble nitrogen through the solution for 10 min., and determine the percentage of cadmium and lead polarographically by the comparative method.

Discussion

Analyses of Bureau of Standards alloys were made to determine the precision and accuracy of the foregoing procedures.

Straight-line curves were obtained when the concentrations of lead, copper, and cadmium were plotted against the current measured in microamperes. However, for the following reasons the comparative method of analyses recommended by Taylor[3] and Meites[4] was used. Meites points out that in many situations the measured wave heights are not exactly proportional to the concentration of the substance reduced and that the analyst is, therefore, forced to resort to comparison with data of accurately known concentrations. Taylor recommends the comparative method as the best for both routine analyses and others where a high degree of precision is required. The comparative method also minimizes many experimental uncertainties, such as mass of mercury drop, temperature, and drop time, which affect the polarographic wave.

As this method was developed for routine control analysis, the use of a silver wire (Fig. 1) proved very reliable. The chance of contaminating the wire with mercury was less than if the wire was wrapped around the capillary, as suggested by Lingane.[5] All analyses were run at room temperature, which varied less than 2° during any 8 hr. period. The room temperature was kept between 25° and 27°C.

The Aluminon method has been used successfully for the determination of 0·1-80 per cent aluminium. Interfering ions were negligible in most zinc solutions. As much as 50 mgm. of ferrous ions can be present when the Aluminon buffer solution is added to the sample. Up to several tenths of a milligram of ferric ion may also be present. According to Bogdanova[6] the addition of 1 mL. of 0·5 per cent ascorbic acid solution prevents the ferric ion from interfering in the analysis.

No interference was encountered in the colorimetric determination of iron. In the polarographic analysis of copper the wave for the ferric ion overlaps that of the copper in many supporting electrolytes, but ferrous ion is reduced at a much more negative potential. Therefore, the iron interference can be eliminated by reducing it to the ferrous state with hydroxylamine hydrochloride and running the copper in the same solution.

A survey of several large manufacturers of zinc alloys revealed that the average time for a spectrographic analysis ranged from 25 min. to 2 hr. The relative deviation from the actual concentration ranged from ±3 per cent to ±10 per cent. It is estimated that the approximate cost of instruments used by these concerns ranged from three to eight times that of the instruments required for the procedures described above. The polarograph and the spectrometer are versatile instruments and could be used for many other determinations in a secondary metals plant.

References

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3. J. K. Taylor; *Anal Chem.*, 1947, **19**, 368.
4. Louis Meites; Polarographic Techniques: Interscience Publishers, New York, N.Y., 1955.
5. James J. Lingane; *Ind. Eng. Chem.*, Anal. Ed., 1944, **16**, 329.
6. I. V. Bogdanova; *Zavodskaya Lab.*, 1955, **21**, 1043.

Russian Castings Production

As part of its service to the foundry industry, the British Cast Iron Research Association has undertaken the publication of a complete cover-to-cover translation of the monthly Russian foundry journal *Liteinoe Proizvodstvo*. It will appear under the title "Russian Castings Production", and will form part of the programme of Russian translations sponsored by the Department of Scientific and Industrial Research.

Liteinoe Proizvodstvo is the leading Russian monthly for the foundryman; all aspects of castings production are covered, from raw materials through melting processes and equipment, moulding sands and methods, casting and fettling, to the service behaviour of the finished product.

While emphasis is placed on cast iron—grey, white, malleable, nodular and alloy—and steel castings, there are also articles dealing with non-ferrous and, particularly, light alloy castings.

The first edition of Russian Castings Production will appear in May 1961, being the January 1961 issue of *Liteinoe Proizvodstvo*. Publication will normally be four months after date of Russian issue.

Subscription rates for 12 issues are £10 10s. 0d. in U.K. and $35 or £12 10s. 0d. outside U.K. Single copies may be purchased at £1 10s. 0d. in U.K., or $5 or £1 15s. 0d. outside U.K.

All enquiries and orders should be addressed to the Publications Officer, British Cast Iron Research Association, Bordesley Hall, Alvechurch, Birmingham, England.

Copper Alloys

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evidence for low temperature movement in the alpha phase of the copper-zinc system, in the silver-zinc system phase you can get well defined transformations even at very low temperatures. These will occur during polishing under liquidation to ensure minimum temperatures even at room temperature. If one carries out the polishing or powdering techniques with a view to keeping internal stresses to the minimum, producing powders which do not produce a colour change, then in annealing experiments at 80° or 90°C. this effect is quite pronounced and in a few minutes the transformation occurs.

A vote of thanks to the authors, proposed by the chairman, was carried with acclamation, and the session then terminated.

Industrial News *Home and Overseas*

A Golf Meeting

Early notice is given of the next meeting of the **National Association of Non-Ferrous Metal Merchants Golfing Society,** which will be held on Wednesday, May 17, at the Wentworth Golf Club, Surrey, commencing at 9.30 a.m.

The annual general meeting and dinner of the society will be held at the May Fair Hotel, London, W.1, on Tuesday, May 16. Full details of both these events may be obtained from Mr. G. B. Garnham (J. B. Garnham and Sons Ltd., Plantation House, Mincing Lane, London, E.C.3).

Belgian Aluminium Rolling Mill

Recent news from Brussels is to the effect that the Belgian firm, SA Laminoirs de l'Escaut, at present operating a foundry with a monthly capacity for 800 tons, will set up a further foundry, bringing its monthly capacity to 2,800 tons. The expansion of its rolling mill plants has brought the company's rolled aluminium capacity to 1,000 tons monthly with a further expansion of 3,000 tons now under way.

Copper Smelting in India

According to press reports from Jaipur, a copper smelter plant to produce 10,000 tons of copper annually will be built at Khetri, in the public sector, during the Third Plan, for which the Government of India has sanctioned 50,000,000 rupees of foreign exchange.

It has been suggested to the Government, however, that the plant should have a production capacity of 25,000 tons of copper annually, an official spokesman added. He said there was copper ore in an 18 mile belt in the Khetri area—only a small part of which had been explored by the Indian Bureau of Mines. In addition there was high percentage copper ore in the nearby area of Baireth.

New Metals Division

An announcement from **Dewrance and Company Limited** concerns the formation of the Dewrance Metals Division, which will consist of the foundry at Hillington and the special alloys division in London.

This new division will have its own board of management and will be responsible for the production and sales of high quality non-ferrous castings, nickel alloy castings, stainless steel castings, "Endewrance" hardfacing and high temperature brazing alloys. The production executive is Mr. J. B. Morton, situated at Hillington, and the sales and technical executive is Mr. E. Wallace, in London.

Damage to Floors

A problem in many foundries is to prevent pitting and spalling of concrete floors when hot ingots are placed on them. It is reported that several companies have overcome this difficulty by using refractory concrete floors reinforced with Hexmetal, which is a honeycomb structure made from strips of steel, stainless iron, aluminized steel strip, or non-ferrous metals, according to specifications.

When hot ingots are placed on this type of flooring, the honeycomb of metal absorbs the heat and dissipates it evenly over the surface, thus avoiding cracking. The structure acts both as a binder and separator, and will absorb heavy impacts without damage to the surface. Hexmetal can be infilled with common concrete, granolithic or asphalt.

The joints are flexible and the material thus has excellent resistance to thermal shock, abrasion and impact load. The use of cotter pins for joining the material also gives the floor increased resistance to corrosion as the pins are unstressed and less liable to corrode.

Hexmetal is manufactured by **Causeway Reinforcement Ltd.,** and is available in many forms and stock sheets measuring 10 ft. by 3 ft. A wide range of standard gauges and sizes is available, and special shapes and sizes can be made to special specifications.

New Foseco Company

The formation of a new company has been announced by Foseco International and the Fordath Engineering Company. This joint company has been brought into being to license the manufacture and marketing of the Fordath range of core binder products in world markets outside the United Kingdom. It will be known as **Foseco-Fordath Ltd.** It is understood that specialized foundry equipment manufactured by Fordath is not included in the agreement and will continue to be marketed exclusively by the manufacturer in all markets.

Promotional Work on Lead

A series of exploratory meetings was held in London during the early part of this month on European promotional work on lead. The meetings were attended by heads of the lead development associations of France, Germany, Great Britain, Italy, and a representative from the Belgian lead industry. The work of each association was discussed and an exchange of views took place on the main uses of lead in each country. Possible new applications, such as sound attenuation, were explored and it was agreed that samples of publications and booklets would be exchanged. Before the meetings ended plans were made for further co-operation and it was agreed, at the invitation of Istituto Italiano del Piombo e dello Zinco, to hold a further meeting in Rome next September, to which representatives from other European countries would be invited.

The meeting noted with satisfaction that the consumption of lead had steadily increased in recent years.

Anti-Corrosion Advances

Latest British achievements in protecting metals against corrosion were shown to parties of experts from Western Europe, the United States, Canada and Japan, at the laboratories of the **British Non-Ferrous Metals Research Association** last week.

The visitors, who were attending the first international congress on metallic corrosion in London, saw examples of the research work which has helped to make the British tube manufacturing industry one of the world's leading exporters of copper alloy tubes. They were told by Mr. G. L. Bailey, Director of B.N.F.M.R.A., that it was his association which had been largely responsible for developing the

Visitors to the laboratories of the British Non-Ferrous Metals Research Association last week were shown work in progress on a study of the corrosion resistance of aluminium bronze plates of the type used for heat exchangers and pressure vessels in oil refineries

resistant copper alloys used in high-efficiency condensers for naval vessels, merchant ships, power stations and oil refineries in Britain.

Another success story from the laboratories demonstrated to the visitors was the victory, after long research, over the corrosion of copper pipes carrying domestic water supplies. In the case of brass pipe fittings for domestic hot water systems, it was explained, the B.N.F. had been able to show that the cause of corrosion lay in water composition, with the result that several public supply authorities were adjusting the composition.

Particular interest was shown in the extensive work being done on nickel chromium plating for motor cars. They saw, on the roof of the laboratories, racks of car fittings that have been weathering for a year or more to demonstrate the difference in corrosion behaviour between the normal types of coatings and the improved coatings being developed by B.N.F.M.R.A.

Mr. Bailey also explained to the visitors the prominent part which B.N.F. is taking in developing accelerated corrosion testing as a means of differentiating between good and bad plating without the necessity for long-term outdoor exposure tests.

A Removal

New offices have recently been occupied by **D. L. Lombard and Sons Engineering Ltd.**, at 19 Grosvenor Place, London, S.W.1, with the telephone number of Belgravia 7745/6. It is reported that the company has received an order for a self-contained 500 ton Lombard forging press from India Pistons Ltd., of Madras.

This press is to be installed in one of the most up-to-date plants for the manufacture of pistons, piston rings, cylinder liners, gudgeon pins, etc. It is interesting to note that British-built Lombard plant installed within the past year includes a 1,500/1,700 ton self-contained automatic extrusion press, a 45 ton stretcher, a three-coil induction billet heater, and a section corrector. The company also now handle the complete range of Lombard mechanical and hydraulic drawbenches, including single, triple, and five tube types from 10,000 lb. to 350,000 lb.

Visitors from China

Among recent visitors to the Bromsgrove factory of **Garringtons Limited** were Mr. Chu Kang-Chieh, the Deputy General Secretary for the China Council for the Promotion of International Trade, and Mr. Tao Li-Chung, B.Sc., a technical consultant for the Council. They are spending a month in the U.K. to explore the sort of equipment which British Industry has to offer and which will be of use to the Chinese expansion programme under the new five-year development plan.

The visitors were entertained by Mr. G. D. Phillips, director and general manager of the induction heating division of Garringtons, Mr. K. L. Moon, sales manager, and Mr. J. D. Humphries, chief electrical engineer. During their tour of the works the visitors were greatly impressed by what they saw, and expressed particular interest in the company's induction heating equipment, stating that there is a continuous expansion of hydro-electric power in China, which would enable such modern equipment to be successfully employed.

Rolling Mill Plant

A continuous billet mill built by Schloemann Aktiengesellschaft, Düsseldorf, for the Esch works (Luxembourg) of ARBED, has been put into operation. It is designed for the production of $2\frac{1}{8}$ in. $\times 2\frac{1}{8}$ in. and $3\frac{1}{8}$ in $\times 3\frac{1}{8}$ in. billets. As the mill schedule permits the use of uniform roll passes, all the train's eight stands can be powered by a single motor. With the aid of electrical and hydraulic equipment each stand can be shifted to a fixed pass line. All stands are provided with hydraulic roll-changing rigs, so that down times are kept to an absolute minimum.

A similar eight-stand continuous billet mill is being built by Schloemann for the Burbach works (near Saarbrücken) of ARBED. This plant is intended for rolling $2\frac{7}{8}$ in $\times 2\frac{7}{8}$ in. or $3\frac{1}{8}$ in $\times 3\frac{1}{8}$ in. respectively. It is scheduled for operation at the end of 1962.

Non-Ferrous Club

Final details of the arrangements for the annual Spring Meeting of the **Non-Ferrous Club Golfing Society** have now been released. This event will take place at the Stratford-on-Avon Golf Club on Tuesday, June 20, commencing at 9.30 a.m. Two rounds will be played: a Stableford competition in the morning for the METAL INDUSTRY bowl, followed in the afternoon by a Greensome against bogey.

Lunch will be served in the Club House, and in the evening a dinner has been arranged at the Welcombe Hotel, Stratford-on-Avon, during which the presentation of prizes will be made. The annual general meeting of the society will be held following the dinner.

A Physics Prize

On Wednesday, May 3 next, at the Physics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7, a meeting of the Institute of Physics and the Physical Society will be held at which the Charles Chree Medal and Prize will be presented to Dr. Scott E. Forbush, of the Carnegie Institution of Washington.

The meeting will commence at 5 p.m., and Dr. Forbush will give an address on the Equitorial Electro-Jet in Peru. Tickets for this event are not required and visitors will be welcomed.

Training in Electronics

A school for training engineers in the use of electronic equipment has been established by **Associated Electrical Industries Ltd.** at New Parks, Leicester, headquarters of the Electronic Apparatus Division. Trainees include not only members of the company's construction department, but also customers' engineers.

The courses will enable AEI construction department electronic specialists to keep up to date with the rapid and advanced developments taking place within the electronics industry; to extend the knowledge of engineers specializing in heavy current electronic engineering; and to train newly qualified engineers in current techniques in industrial electronics.

At present there are two types of courses — the advanced, dealing with electronic machine tool control systems, lasting approximately five weeks, and an elementary course, on simpler equipments, over five days.

Giant Mill Housing Delivered

A 180-ton mill housing was delivered on Monday this week to the Kitts Green, Birmingham, works of **James Booth Aluminium Limited.** It is the first of two housings for their new aluminium rolling mill—the largest of its type in Western Europe — and was transported on the largest trailer in the country.

The trailer was a 200-ton 32-wheeler built by Cranes of Dereham. It was hauled from the Netherton, Liverpool, works of The English Electric Co. Ltd. and the casting was off-loaded from the trailer in the docks at Liverpool and taken across the Mersey to Birkenhead for reloading, lashed to the deck of the Mammoth 200-ton floating crane, which was towed by two tugs.

The combined weight of the trailer and casting was 205 tons, and although the journey from Liverpool to Birmingham is only about 90 miles it took four days, the route being selected specially to avoid narrow roads and bridges with weight restrictions. The housing is one of the heaviest loads ever transported on British roads.

Last October the casting was taken by road from the Sheffield foundry of The English Steel Castings Corporation Ltd., —where it was cast to the order of The Loewy Engineering Co. Ltd., Bournemouth—for machining at Liverpool.

Nuclear Engineering

Three well-known industrial concerns, **Imperial Chemical Industries Ltd. (Metals Division), Rolls-Royce Ltd.,** and **The Rio Tinto Co. Ltd.,** have jointly formed a new company to operate in the field of civil nuclear engineering in collaboration with the atomic power consortia. The new company is to be called **Nuclear Developments Ltd.** and the United Kingdom Atomic Energy Authority has been kept fully informed of its formation.

Each of the participants has experience which will be appropriate to the future role of the new company in nuclear engineering. Rio Tinto mines, extracts and processes uranium on a large scale. Rolls-Royce has been engaged in the nuclear field for the past eight years and has a specific interest in marine nuclear propulsion. I.C.I. Metals Division has made several notable contributions to technological progress in nuclear engineering over the last twenty years and has exceptional facilities for the manufacture of nuclear metals and reactor components.

With these combined resources at its disposal, Nuclear Developments Limited will be able to meet demands, as and when they can be met by private industry, for fuel preparation and fuel element manufacture for civil reactors.

Super Purity Aluminium

New facilities for refining super purity aluminium have been installed at Kaiser Aluminum and Chemical Corporation's Mead, Washington, U.S.A., reduction plant, increasing by 55 per cent the company's capacity to produce the 99.99 plus pure aluminium, it was announced this week.

Five new specially designed refining cells—the largest of their type in the industry—are now in full operation. Each cell has a rated capacity in excess of 380,000 lb/yr., making Kaiser Aluminum's production capacity for the metal more than 5,300,000 lb. annually.

Low Cost Automation

Speaking to a meeting of the Merseyside Productivity Association on "Low Cost Automation", Mr. L. Landon Goodman, Industrial Specialist, Electrical Development Association, said that the term "Low Cost Automation" had been defined as "a replacement of muscular and mental effort by the use of simple pneumatic, electric, hydraulic and mechanical components in manufacturing and assembly operations". There was wide scope for low cost automation in most types of industries, particularly where

large numbers of manual operations were undertaken. A feature of low cost automation was the use of simple types of equipment which could be employed again and again—air cylinders, solenoids, valves, timers and photo-electric cells. Most applications involved the addition of these simple "building blocks" to existing plant and machinery, such as machine tools, guillotines, bending machines and mixers. Other applications sometimes required no more than the building of a simple frame or the use of an indexing unit on which the building blocks were mounted. Because of this inherent versatility, low cost automation could be well and profitably applied to batch production.

Welfare in Drop Forging

To advise the Minister of Labour on matters affecting the health, safety and welfare of persons employed in the drop forging industry, the Joint Standing Committee on Health, Safety and Welfare in the Drop Forging Industry has been re-appointed for a further three years. It replaces and will continue the work of the Joint Standing Committee for the Drop Forging Industry which was set up by the Chief Inspector of Factories in 1954.

Mr. A. B. E. Lovett, H.M. Superintending Inspector of Factories for the Midland (Birmingham) Division has been appointed chairman, and the other members are:—Mr. J. Jarvie (Associated Blacksmiths', Forge and Smithy Workers' Society); Mr. F. W. Crowder (Amalgamated Engineering Union), Mr. R. B. H. Purchase (Engineering Employers' Federation), Mr. J. C. Beech (Messrs. Garringtons Ltd.), Mr. J. E. Profitt (Iron and Steel Trades Confederation), Mr. G. Kemp, Mr. A. L. Stuart Todd and Mr. M. C. Vaughan (National Association of Drop Forgers and Stampers), Mr. E. J. Beard (Transport and General Workers Union). The secretary is Mr. G. S. Lyndon, H.M. Inspector of Factories.

British Instruments Overseas

At the forthcoming British Trade Fair in Moscow, **George Kent Limited** are showing a number of practical examples of the very latest developments in measuring techniques and applicational versatility. Operation of several exhibits under simulated working conditions will ensure realism.

In addition to participating in the Moscow Fair, Kent are also showing a selection of their products at the 13th Exhibition and Congress of Chemical Engineering (Stand G10) forming part of the 1961 ACHEMA Congress, Frankfurt on Main, June 9 to 17.

Export Centre

To aid Britain's intensified export drive, a residential centre for export studies is being opened in June for top management at Sundridge Park, Kent.

Organized by the Sundridge Park Management Centre, in consultation with a special advisory panel set up by the Federation of British Industries, it will provide intensive training at top level for Britain's exporting firms. Courses will last for three weeks and will be repeated at regular intervals throughout the year; they will be mainly intended for export directors and senior executives concerned with the promotion of exports. All aspects of the development and control of exports will be covered, the principles and techniques discussed being equally applicable to both large and small organizations handling products ranging from capital equipment to consumer goods.

Enquiries should be addressed to the Director, Sundridge Park Management Centre, Bromley, Kent.

Record U.S. Copper Production

Refined copper production in the U.S.A. in 1960 set a record of 1,800,000 tons, while exports of 435,000 short tons were the highest in more than 30 years, according to the U.S. Commerce Department. Scrap exports also reached a new peak.

Brass mill product imports were substantially down from the record year of 1959, but copper wire and cable imports of 12,000,000 lb. tripled the 1959 figure.

Brassfounders Move

Redevelopment of the Brunswick Street area of Stockton is leading the **Reay Brass Foundry Co. Limited,** of West Row, Stockton, to move its premises to a new 16,000 ft^2 main factory which is being built on a three-acre site in Portrack Road, Stockton The new factory is scheduled for completion in July, and the new foundry building, despatch bay and machine shops will cover a frontage of 200 ft. with a depth of 105 ft. Provision is also being made for a welfare block and canteen, showers and individual lockers for employees, and an office block and pattern store, and room is available on the site for the floor area to be doubled should future expansion call for this.

Metal Stocks

At the end of last week, stocks of refined tin in London Metal Exchange official warehouses fell 98 tons to 10,183 tons, comprising London 4,289, Liverpool 3,756 and Hull 2,138 tons.

Copper stocks fell 401 tons to 14,967 tons, comprising London 625, Liverpool 12,192, Birmingham 100, Manchester 2,000, Swansea nil, and Hull 50 tons.

Lead duty-free stocks rose 250 tons to 8,064 tons, while in-bond stocks rose 182 tons to 3,868 tons. All supplies were in London.

Zinc duty-free stocks rose 223 tons to 4,301 tons, while in-bond stocks rose 425 tons to 775 tons, comprising London duty-free 2,808 tons and in-bond 775 tons, Liverpool duty-free 1,473 tons and in-bond nil tons, and Glasgow duty-free 20 tons and in-bond nil tons.

Foundry Equipment at Moscow

Specially constructed for display at the forthcoming British Trade Fair in Moscow, a one-tenth scale working model of the Hallsworth automatic moulding system is being shown by **Rubery Owen and Co. Ltd.,** Foundry Equipment Department.

In contrast to conventional equipment, the Hallsworth automatic moulding system employs the principle of using relatively small, easily handled boxes with complete automatic equipment as and where necessary, but still retains the human element where justified by economics.

Consequently, in the manufacture of the smaller type of casting, a small, rapidly moving box yields a greater output per man than a large box, where the time cycle is adversely affected by both operator fatigue and the necessity for larger and expensive mechanical handling equipment. The plant produces 480 half moulds each hour.

Bolivian Tin Output

From May onward, Bolivian tin production is to be raised to 1,500 tons a month. The current level is 1,150 tons.

During the first quarter of this year, the mines sustained a loss of $2,300,000. Reports indicate, however, that May will probably mark the start of a recovery of the nationalized mines under a five-year development plan. This will be launched on May 1 with an initial investment of about $10,000,000 as part of a $40,000,000 so-called triangular loan. The credits are being granted in equal parts by the United States Government, the Inter-American Development Bank and West Germany (through the firm of Saltzgitter Machinen Aktiengesellschaft).

Showing in Canada

The largest stand within the joint Board of Trade and Birmingham Engineering Centre display at the Canadian Production Show, which opens on May 8, is being taken by **The Delta Group of Companies**. Mr. George Meredith, sales director of Heaton and Dugard Limited, a member of the Delta Group, sailed on April 20 to attend the show and tour Delta's interest in Canada.

The Delta display at the Canadian Show will include extruded rods and sections, in brass, bronze and copper; solid drawn tubes in copper; wire in brass, phosphor bronze and copper; rolled strip in brass and copper; cramps, dowels, tie-rods, etc., in "Delta" Bronze No. IV.

In addition, Delta's Canadian Group member, Wallaceburg-Singer Ltd., Wallaceburg, Ontario, will display forgings, cored and solid, in brass, copper and aluminium.

Obituary

Prof. C. W. Dannatt

WE regret to record the death of Professor Cecil William Dannatt, Professor Emeritus at London University. A graduate of the Royal School of Mines, after service in the 1914-18 war he gained experience abroad and returned there in 1923 as a research assistant, later joining the teaching staff.

He was appointed Assistant Professor and London University Reader in Metallurgy in 1937, becoming Acting Director of the department in 1943. In 1945, he was appointed to the Chair, which he occupied until his retirement in 1957. Later in the same year the title of Professor Emeritus was conferred on him, and in 1960 he became a Fellow of Imperial College.

He had been a vice-president of the Institution of Metallurgists, and President of the Institution of Mining and Metallurgy.

Mr. E. E. Thum

WE also regret to record the death of Mr. Ernest E. Thum, editor-in-chief of our American contemporary, *Metal Progress*, the official journal of the American Society for Metals.

Forthcoming Meetings

April 26 — Southampton Metallurgical Society. Southampton Technical College (Joint Meeting with Institute of British Foundrymen). "The Development of Cast Metals." Dr. H. T. Angus. 7.15 p.m.

April 28 — Institute of Metal Finishing. Sheffield and North East Branch. Grand Hotel, Sheffield. 7 p.m.

Metal Market News

LAST week's turn of events on the Metal Exchange centred round the tin ring, for the metal gave a display of great strength although the quotation closed something like £10 below the highest point reached during the week's trading. A very strong price trend in Singapore seems to have been mainly responsible for this upswing in Whittington Avenue, but good buying of the metal was reported from the United States. Metal Exchange warehouse stocks rose by 17 tons to 10,281 tons, but this had absolutely no effect on the course of the price, which rose steeply till mid-week when cash on the afternoon market touched £846, with three months at £852. This, however, proved to be the top, for the Far Eastern market turned down and London followed, so that by the time trading came to an end on Friday afternoon the quotation stood at £837 for prompt and £842 10s. 0d. forward. Even so, this showed a gain of £7 10s. 0d. for cash and £9 10s. 0d. three months. The turnover was exceptionally high, amounting as it did to 2,530 tons. It is thought that the market is all the healthier for the shake-out last week, and there are plenty of people who foresee a further appreciation, which will carry the price well above £850. Indeed, there are those who believe that we may well see the quotation as high as £900.

Just what the tactics of the Pool were last week is not known, but it is generally assumed that the Manager was selling cash tin on some of the sessions. The price is now in the range at which the Tin Pool Manager is permitted to sell, but if and when the price rises beyond £880 then he *must* sell. Opinion appears to be that the Pool comprises something like 10,000 tons, which is not by any means too much in the circumstances. Indeed, the selling campaign will take some planning, for care must be taken not to run out of "ammunition". In the meanwhile, it seems likely that a fairly big bull account still exists in the tin futures market even after the bout of liquidation during the second half of last week. Sentiment is certainly decidedly favourable.

No great change was to be noted in the other metals, for although copper rallied smartly in midweek, the quotation fell back again, so that at the close cash was 15s. lower on balance at £228 while three months finished unchanged at £229 10s. 0d. The turnover was above average at 13,500 tons. Warehouse stocks rose by 396 tons to 15,368 tons. Throughout most of the week sentiment was buoyed up by the thought that there would be an advance in the Custom Smelters' quotation, but when on Friday it was reported that Kennecott had decided to return to a seven-day week, this hope faded away. In midweek cash touched £231 and three months £232 5s. 0d. There was an increase of 375 tons in Metal Exchange stocks of lead to 11,682 tons, and after trading amounting to 6,500 tons, cash closed £1 down at £66 and three months 10s. off at £67 10s. 0d. In zinc, about 5,500 tons changed hands, cash closing 2s. 6d. down at £83 15s. 0d. and three months 5s. up at £83 17s. 6d.

Birmingham

Manufacturers in the motor trade are stepping up production to meet heavier sales. That is the position in the Midland area, where nearly every firm has returned to normal working, including night shift operation. This is mainly due to valuable export business booked in America and on the Continent. The outlook has certainly changed very rapidly in the last few weeks. Other departments of the metal and engineering industries are actively engaged. There are many vacancies in Midland industry, particularly for skilled men. All branches of the building trade are well occupied and there is a good demand for pressings, fittings and castings.

The iron and steel trade maintains a high rate of production in all departments. Foundries are much busier than they were even a month ago, and consumption of foundry grades of pig iron is expanding. Suppliers have no difficulty in meeting the extra demand. More steel sheet is required by the motor industry. Re-rolling firms are exceptionally busy on reinforcing rods and bars for building work. The plate mills have enough orders to absorb present output. Demand for joists and sections is heavy but delivery can be obtained without unreasonable delay.

New York

Last week, copper futures began firm on covering and new buying in fairly active dealings. Traders said there was some slackening in Japanese demand, but the squeeze on custom smelters generated by another ¼ cent rise in the scrap copper price to 24¼ cents per lb., added pressure for a custom smelter price rise.

Producers were still selling freely at 29 cents, and this source said he did not believe producers would advance their price even if custom smelters did so. The export copper market was very steady. Tin was strong. Buyers showed interest in the lower priced non-Straits tin. Lead and zinc were quiet.

Copper futures, after early easiness following London advices, rallied towards last week-end on speculative buying to close around previous levels. Dealings were active. Producers were active sellers at the price of the date of shipment, currently 29 cents, while custom smelters were selling on an average price basis.

On Friday last, copper futures were easier, but later in the day the market held steady. Traders said that Japanese demand had slackened and there was a barely steady undertone to the export price. Leading copper sources indicated that an important reason for the Kennecott step-up in production was that company's anxiety about a possible strike on July 1.

Tin was again easier but quiet. Lead and zinc were modestly active.

It was announced that the Office of Defense Mobilization had no plans to release any tin from the national stockpile at the present time. The U.S. Government has only 4,000 tons of tin—less than 2½ per cent of world output—available for release without going through onerous legal preliminaries required to issue tin from the national stockpile.

Paris

At a recent conference, M. Raoul de Vitry, President of Pechiney, outlined the past achievements and future hopes of his company. The year 1960 saw the inauguration of two aluminium plants, one at Nogueres and a pilot plant, using a new production method, which is being operated in conjunction with Ugine. Figures for 1960 were 22·5 per cent higher than those of 1959 after deduction of tax. They reached over 72,000,000 lb., of which 21,000,000 lb. were for exports, an increase of 30·5 per cent over 1959.

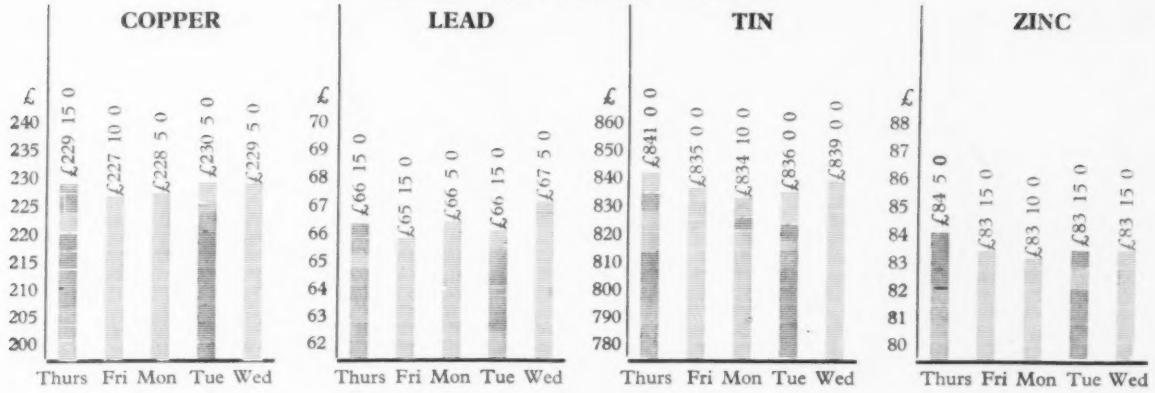
Pechiney consumed one-fifth of the total electricity of France, or 26 per cent more than in 1959. For the first time, bauxite production exceeded 1,000,000 tons. 187,000 tons of aluminium were produced against 144,000 tons in 1959, or an increase of 30 per cent. The company delivered 259,000 tons, against 217,000 tons in 1959, or an increase of 26 per cent.

Turning to 1961, M. Vitry said that if the company's hopes were realized figures would rise to 82,500,000 lb. He said that if the first two months of 1961 were any indication, then the company's hopes would be realized; but it would be unwise to be too optimistic. The Common Market and growing competition from America could lead to problems. It was absolutely necessary, therefore, to keep prices down. Pechiney was using new production methods, and these would certainly contribute towards realizing the company's bright hopes for this year. The pilot plant at Nogueres, which was using these new processes, showed economies of up to 50 per cent.

Non-Ferrous Metal Prices

London Metal Exchange

Thursday 13 April to Wednesday 19 April 1961



Primary Metals

All prices quoted are those available at 2 p.m. 19/4/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	„	237	10	0
Antimony Metal 99%	„	230	0	0
Antimony Oxide Commercial	„	194	10	0
Antimony White Oxide	„	212	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		11	0
Calcium	„	2	0	0
Cerium 99%	„	15	0	0
Chromium	„		6	11
Cobalt	„		12	0
Columbite per unit			8	10	0
Copper H.C. Electro	ton	229	5	0
Fire Refined 99·70%	„	228	0	0
Fire Refined 99·50%	„	227	0	0

		£	s.	d.
Copper Sulphate	ton	77	0	0
Germanium	grm.		—	
Gold	oz.	12	10	7½
Indium	„		10	0
Iridium	„	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	67	5	0
Magnesium Ingots	lb.			
99·8%	„		2	2½
99·9+%	„		2	3
Notched Bar	„		2	9½
Powder Grade 4	„		5	6
Alloy Ingot, AZ91X		1	11¾-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	67	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.	20	0	0
Osmiridium	„		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	„	30	5	0
Rhodium	„	46	0	0
Ruthenium	„	16	0	0
Selenium	lb.	2	6	6
Silicon 98%	ton	122	0	0
Silver Spot Bars	oz.		6	7⅛
Tellurium Sticks	lb.	2	0	0
Tin	ton	839	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	83	17	6
Dust 95/97%	„	125	0	0
Dust 98/99%	„	131	0	0
Granulated 99+%	„	108	17	6
Granulated 99·99+%	„	123	16	3

**Duty and Carriage to customers' works for buyers' account.*

Foreign Quotations

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg≏£/ton	**Canada** c/lb≏£/ton	**France** fr/kg≏£/ton	**Italy** lire/kg≏£/ton	**Switzerland** fr/kg≏£/ton	**United States** c/lb≏£/ton
Aluminium		26.00 210 12	2.43 179 11	370 216 1	2.50 210 5	26.00 207 4
Antimony 99.0			2.55 188 8	520 303 13		32.50 259 0
Cadmium			15.75 1,069 0			160.00 1,275 4
Copper						
Crude				440 256 19		
Wire bars 99.9						
Electrolytic	31.75 232 1	27.50 222 15	3.20 236 9		2.75 231 5	29.00 231 6
Lead		10.00 81 0	.96 70 18	165 97 7	.78 65 11	11.00 87 13
Magnesium						
Nickel		70.00 567 0	9.00 665 2	1,180 689 2	7.50 630 15	74.00 589 15
Tin	117.25 856 19		11.88 878 18	1,590 928 11	9.65 811 11	108.50 864 14
Zinc						
Prime western		12.25 100 4 0				
High grade 99.95		12.85 104 17 0				
High grade 99.99		13.25 107 6 0			1.10 92 10	
Thermic			1.23 90 17			
Electrolytic			1.31 96 16	189 110 7		13.00 104 0

Non-Ferrous Metal Prices (continued)

Ingot Metals

All prices quoted are those available at 2 p.m. 19/4/61

	£	s.	d.
Aluminium Alloy (Virgin)			
B.S. 1490 L.M.5 .... ton	210	0	0
B.S. 1490 L.M.6 .... „	202	0	0
B.S. 1490 L.M.7 .... „	216	0	0
B.S. 1490 L.M.8 .... „	203	0	0
B.S. 1490 L.M.9 .... „	203	0	0
B.S. 1490 L.M.10.... „	221	0	0
B.S. 1490 L.M.11.... „	215	0	0
B.S. 1490 L.M.12.... „	223	0	0
B.S. 1490 L.M.13.... „	216	0	0
B.S. 1490 L.M.14.... „	224	0	0
B.S. 1490 L.M.15.... „	210	0	0
B.S. 1490 L.M.16.... „	206	0	0
B.S. 1490 L.M.18.... „	203	0	0
B.S. 1490 L.M.22.... „	210	0	0
Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 .... ton	171	0	0
B.S. 1490 L.M.2 .... „	174	0	0
B.S. 1490 L.M.4 .... „	180	0	0
B.S. 1490 L.M.6 .... „	181	0	0
***Aluminium Bronze**			
BSS 1400 AB.1..... ton	247	0	0
BSS 1400 AB.2..... „	255	0	0

	£	s.	d.
***Brass**			
BSS 1400-B3 65/35 .. ton	179	0	0
BSS 249 ..... „		—	
BSS 1400-B6 85/15 .. „	227	0	0
***Gunmetal**			
R.C.H. 3/4% ton .... „		—	
(85/5/5/5) LG2 ..... „	223	0	0
(86/7/5/2) LG3 ..... „	233	0	0
(88/10/2/1) ..... „	286	0	0
(88/10/2/½) ..... „	296	0	0
***Manganese Bronze**			
BSS 1400 HTB1..... „	197	0	0
BSS 1400 HTB2..... „	214	0	0
BSS 1400 HTB3..... „	232	0	0
Nickel Silver			
Casting Quality 12% „	245	0	0
„ „ 16% „	260	0	0
„ „ 18% „	300	0	0
***Phosphor Bronze**			
B.S.1400P.B.1.(A.I.D. released) ..... „	313	0	0
B.S. 1400 L.P.B.1 „	244	0	0

**Average prices for the last week-end.*

	£	s.	d.
Phosphor Copper			
10% ..... ton	256	0	0
15% ..... „	258	0	0
Phosphor Tin			
5% ..... „	919	0	0
Silicon Bronze			
BSS 1400-SB1 ..... „	290	0	0
Solder, soft, BSS 219			
Grade C Tinmans ... „	383	10	0
Grade D Plumbers .. „	306	10	0
Grade M ..... „	422	5	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „ „		—	
Zinc Alloys			
BSS 1004 Alloy A .. ton	117	6	3
BSS 1004 Alloy B.... „	121	6	3
Sodium-Zinc ..... lb.		2	7

Semi-Fabricated Products

Prices vary according to dimensions and quantities. The following are the basis prices for certain specific products.

		s.	d.
Aluminium			
Sheet 10 S.W.G. lb.		2	10½
Sheet 18 S.W.G. „		3	0½
Sheet 24 S.W.G. „		3	3½
Strip 10 S.W.G. „		2	10½
Strip 18 S.W.G. „		2	11½
Strip 24 S.W.G. „		3	1
Circles 22 S.W.G. „		3	4½
Circles 18 S.W.G. „		3	3½
Circles 12 S.W.G. „		3	2½
Plate as rolled ..... „		2	10
Sections ..... „		3	4
Wire 10 S.W.G. .... „		3	1½
Tubes 1 in o.d. 16 S.W.G. ..... „		4	4
Aluminium Alloys			
BS1470. HS19W.			
Sheet 10 S.W.G. „		3	3
Sheet 18 S.W.G. „		3	5½
Sheet 24 S.W.G. „		4	1
Strip 10 S.W.G. „		3	3
Strip 18 S.W.G. „		3	4½
Strip 24 S.W.G. „		4	0½
BS1477. HP30M.			
Plate as rolled ..... „		3	1
BS1470. HC15WP.			
Sheet 10 S.W.G. „		4	3
Sheet 18 S.W.G. „		4	8½
Sheet 24 S.W.G. „		5	8½
Strip 10 S.W.G. „		4	4
Strip 18 S.W.G. „		4	8½
Strip 24 S.W.G. „		5	4½
BS1477. HPC15WP.			
Plate heat treated ... „		3	10½
BS1475. HG19W.			
Wire 10 S.W.G. „		4	2
BS1471. HT19WP.			
Tubes 1 in. o.d. 16 S.W.G. ..... „		5	5
BS1476. HE19WP.			
Sections ..... „		3	4
Split tube			
19 S.W.G. (⅛″) ..... „		4	2
20 S.W.G. (3/16″) ..... „		3	11
21 S.W.G. (¾″) ..... „		4	1
22 S.W.G. (¼″) ..... „		4	11
Welded tube			
14 to 20 S.W.G. (sizes ½″ to 1½″) .... „		3/10½ to 5/8½	

	£	s.	d.
Brass			
Tubes ..... lb.		1	10
Brazed Tubes ..... „		3	2½
Drawn Strip Sections „		3	2½
Sheet ..... ton	200	0	0
Strip ..... „	200	0	0
Extruded Bar ..... lb.		2	0½
Condenser Plate (Yellow Metal) ..... ton	188	0	0
Condenser Plate (Naval Brass) ..... „	200	0	0
Wire ..... lb.		2	8¼
Beryllium Copper			
Strip ..... „	1	4	11
Rod ..... „	1	1	6
Wire ..... „	1	4	9
Copper			
Tubes ..... lb.		2	2½
Sheet ..... ton	263	0	0
Strip ..... „	263	0	0
H.C. Wire ..... „	280	5	0
Cupro Nickel			
Tubes 70/30 ..... lb.		3	6½

		s.	d.
Lead			
Pipes (London) ..... ton	107	0	0
Sheet (London) ..... „	104	15	0
Tellurium Lead ..... „	£6 extra		
Nickel Silver			
Sheet and Strip 10%.. lb.		3	10⅛
Wire 10% ..... „		4	3½
Phosphor Bronze			
Wire ..... „		4	1½
Titanium (1,000 lb. lots)			
Billet 4½″ to 18″ dia..... lb.	47/-		48/-
Rod ¼″ to 4″ dia..... „	85/-		53/-
Wire ·036″-232″ dia .... „	159/-		99/-
Strip ·001″ to ·048″.... „	350/-		68/-
Sheet 8′×2′. 20 gauge „	73/-		
Tube, representative average gauge ..... „	198/-		
Extrusions ..... „	90/-		
Zinc			
Sheet ..... ton	122	0	0
Strip ..... „	nom.		

Domestic and Foreign

Merchants' average buying prices delivered, per ton, 18/4/61.

	£
Aluminium	
New Cuttings	141
Old Rolled	114
Segregated Turnings	79
Brass	
Cuttings	162
Rod Ends	145
Heavy Yellow	138
Light	133
Rolled	151
Collected Scrap	137
Turnings	139
Copper	
Wire	207
Firebox, cut up	204
Heavy	202
Light	199
Cuttings	209
Turnings	184
Braziery	180

	£
Gunmetal	
Gear Wheels	204
Admiralty	204
Commercial	189
Turnings	184
Lead	
Scrap	56
Nickel	
Cuttings	—
Anodes	555
Phosphor Bronze	
Scrap	189
Turnings	184
Zinc	
Remelted	76
Cuttings	66
Old Zinc	46

Financial News

Anti-Attrition Metal

Group profit, 1960, £20,739 (loss £95,686). Net profit £21,159 (loss £92,033), including tax credit £420 (£3,653).

F. W. Berk and Co. Ltd.

Group sales, £9,024,200, show 8 per cent increase on the previous year. Profits £334,893 after tax, 26 per cent increase. Dividend 8¼d. per 5s. share on increased capital. Fixed assets £2,196,971 (£1,461,073), commitments £210,000 (£27,000). Net current assets £2,001,682 (£1,575,966).

Bulpitts (Swan Brand) Ltd.

Trading profit down to £592,248 (£685,289). Group net profit for 1960 available to parent company £424,135 (£433,421). Dividend same as previous year at 16¼ per cent. Fixed assets £762,840 (£716,265). Net current assets £1,805,248 (£1,575,752). Commitments £40,000.

W. Canning and Co. Ltd.

Profits rose to a new peak of £657,000 (£600,000). After tax of £347,000 (against £311,000), the net profit went up from £289,000 to £310,000 (figures are before deduction of £42,000 for fixed assets replacement reserve). Dividend 9½d. per 5s. share (9d.).

Glynwed Tubes Ltd.

Group fixed assets £3,336,259 (£2,534,012). Net liquid resources £2,079,749 (£2,494,278). Group turnover, £15,760,000 (£12,780,000). Profit £1,811,496 (£1,231,501). Dividend 22½ per cent (17½ per cent).

Imperial Chemical Industries Ltd.

Manufacturing and trading profits for 1960, after depreciation, were £93,629,000 (£79,755,000) in the case of the group and £74,506,000 (£62,991,000) in the case of the company, thus being 17 per cent higher for the group and 18 per cent higher for the company. After depreciation and profit-sharing, but before taxation, the income in 1960 of the group was £88,044,000 (£73,116,000), and of the company £73,094,000 (£59,514,000).

Depreciation £37,258,000 by the group (£33,138,000), and £29,069,000 by the company (£26,177,000). Taxation provisions were £40,472,000 (£31,531,000) by the group and £33,394,000 (£25,658,000) by the company.

Group income after taxation was £47,572,000 (£41,585,000). The income of the company after taxation for 1960 was £39,700,000 (£33,856,000).

Final dividend of 1s. 6d. per £1 unit recommended, making a total distribution of 2s. 9d. for 1960 (2s. 3d.). Appropriation to General Capital Reserve £4,000,000 and to General Revenue Reserve £13,447,000.

Josiah Parkes and Sons

Group net profit, 1960, £193,802 (£186,402) and dividend 15 per cent (13½ per cent equivalent). Fixed assets £659,954 (£592,440). Current assets £1,427,971 (£1,299,315), liabilities £536,613 (£471,111). Commitments £161,500 (£66,000).

Ratcliffs (Great Bridge)

Group net profit, 1960, £244,616 (£294,976) and dividend 10 per cent (same). Fixed assets £1,395,143 (£1,202,273). Current assets £1,524,438 (£1,681,472), liabilities £318,583 (£352,115).

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

Mond Nickel Co. Limited (684824), Thames House, Millbank, S.W.1. Registered February 28, 1961. Nominal capital, £100 in £1 shares. Director: International Nickel Company (Mond) Ltd., Thames House, Millbank, S.W.1.

Gullick Bros. (Walsall) Ltd. (685054), Wisemore Works, Walsall. Registered March 2, 1961. To carry on business of polishers, platers, stove enamellers, etc. Nominal capital, £6,000 in £1 shares. Permanent directors: Ernest C. Gullick, Richard H. Gullick, Annie E. Gullick, Jean P. Gullick, George A. Gullick and Nora W. Gullick.

Frost and Sons (Metal Spraying) Ltd. (685212), Falcon Galvanizing Works, Moxley, Wednesbury. Registered March 3, 1961. Nominal capital, £10,000 in £1 shares. Directors: Sidney W. Frost, Harry Frost and Sidney Frost.

A. H. Carter (Hampton) Limited (685323), 22 Bloomsbury Square, W.C.1. Registered March 6, 1961. To carry on business of metal workers, etc. Nominal capital, £100 in £1 shares. Directors: Horace O. Rogers and Arthur H. Carter.

Sprayotron Equipment Ltd. (685399), 58 Deeborough Park Road, High Wycombe, Bucks. Registered March 6, 1961. To carry on business of manufacturers of and dealers in spraying equipment, in particular electrostatic paint spraying equipment, etc. Nominal capital, £1,000 in 2,000 founders' shares of 2s. and 800 Ordinary shares of £1 each. Director: Leonard T. F. Bryan.

A. S. Hann and Co. Limited (687471), Island Farm Ave., West Molesey, Surrey. Registered March 23, 1961. To take over business of electroplaters, stove enamellers, etc., carried on as "A. S. Hann and Co." at West Molesey, etc. Nominal capital, £1,000 in £1 shares. Directors: Albert S. Hann, Mrs. Alice V. Hann, David J. Hann, Geoffrey A. Hann and Robert S. Hann.

J. and M. Marshall Limited (687565), Oughtibridge Station, Oughtibridge, near Sheffield. Registered March 23, 1961. To carry on business of wire merchants, metal and machinery merchants, etc. Nominal capital, £2,000 in £1 shares. Directors: Jack Marshall and Mrs. Muriel Marshall.

Scrap Metal Prices

The figures in brackets give the English equivalents in £1 per ton:—

France (new francs per kilo):

Electrolytic copper scrap	(£219.9.0) 2.97
Heavy copper	(£219.9.0) 2.97
No. 1 copper wire	(£205.8.0) 2.78
Brass rod ends	(£166.9.0) 2.25
Zinc castings	(£71.13.0) 0.97
Lead	(£66.10.0) 0.90
Aluminium	(£125.12.0) 1.70

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£178.2.0) 305
Lead, soft, first quality	(£80.0.0) 137
Lead, battery plates	(£44.19.0) 77
Copper, first grade	(£219.0.0) 375
Bronze, commercial gunmetal	(£183.19.0) 315
Brass, heavy	(£152.17.0) 260
Brass, light	(£140.3.0) 240
Brass, bar turnings	(£152.17.0) 260
Old zinc	(£64.4.0) 110

Japan (Yen per metric ton):

Electrolytic copper	(£—)	285,000
Copper wire No. 1	(£—)	265,000
Copper wire No. 2	(£—)	250,000
Heavy copper	(£—)	250,000
Light copper	(£—)	215,000
Brass, new cuttings	(£—)	200,000
Red brass scrap	(£—)	215,000

West Germany (D-marks per 100 kilos):

Used copper wire	(£204.19.0)	225
Heavy copper	(£204.19.0)	225
Light copper	(£182.4.0)	200
Heavy brass	(£132.1.0)	145
Light brass	(£95.13.0)	105
Soft lead scrap	(£52.16.0)	58
Zinc scrap	(£52.16.0)	58
Used aluminium unsorted	(£81.19.0)	90

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for Jan. 1961 have been issued by the Aluminium Industry Council as follows (in long tons):—

Virgin Aluminium	
Production	2,306
Imports	27,259
Despatches to consumers	31,759
Secondary Aluminium	
Production	11,671
Virgin content of above	1,439
Despatches (including virgin content)	10,284
Scrap	
Arisings	12,321
Estimated quantity of metal recoverable	8,963
Consumption by:	
(a) Secondary smelters	12,141
(b) Other uses	1,055
Despatches of wrought and cast products	
Sheet, strip and circles	14,692
Extrusions (excluding forging bar, wire-drawing rod and tube shell):	
(a) Bars and sections	4,168
(b) Tubes (i) extruded	317
(ii) cold drawn	598
(iii) formed strip	—
(c) (i) Wire	1,394
(ii) Hot rolled rod (not included in (c) (i))	92
Forgings	345
Castings: (a) Sand	1,737
(b) Gravity die	3,909
(c) Pressure die	1,481
Foil	2,108
Paste	288

THE STOCK EXCHANGE

Steady Demand Again Reported

ISSUED CAPITAL *	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 17 APRIL +RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£			Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	32/6	11	9	6 15 6	32/6	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/-	NIL	4	NIL	1/-	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries ...	47/9 +3/-	15	15	6 5 9	54/10½	40/3	67/3	38/3
3,895,963	1	Birfield	62/6 —1/6	10	15‡	3 4 0	64/-	45/-	51/3	29/-
4,795,000	1	Birmid Industries	97/6 +1/6	20	20D	4 2 0	97/9	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	36/- —6d.	17½QT	12½	3 6 0	36/10½	24/9	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/3 —3d.	5	5	7 0 3	14/4½	14/-	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	16/9 +3d.	6	6	7 3 3	17/6	16/9	20/-	17/1½
500,000	1	Bolton (Thos.) & Sons	48/9	12½	10	4 6 6	48/9	37/6	43/-	36/-
300,000	1	Ditto Pref. 5%	14/-	5	5	7 2 9	14/6	13/9	16/-	14/3
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	17/-	6	6	7 1 3	18/-	16/6	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	55/6 —3/-	13½	13½	4 17 3	59/9	50/4½	61/4½	47/-
20,456,599	5/-	British Oxygen Co. Ltd., Ord. ...	34/- —1/3	16	16	2 7 0	35/3	26/3	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	20/4½ +7½	15 + 8½C	25 + *2½C‡	3 13 9	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/4½ —1½d.	NIL	12½	—	1/7½	1/-	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	28/-xd	12	10	8 11 6	29/-	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/3	6	6	7 17 6	15/3	15/1½	16/-	15/10½
300,000	2/-	Coley Metals	4/3 +9d.	15	15	7 1 3	4/2½	3/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	77/- +5/9	20	15	5 4 0	77/-	64/-	80/9	59/6
5,399,056	1	Davy-Ashmore	172/6 —3/6	30‡	20	1 12 6	177/6	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	24/6xd +9d.	20	17½	4 1 9	25/4½	19/9	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	45/3xd —3/3	15	15	6 12 6	52/3	45/-	56/9	45/-
1,155,000	1	Evered & Co.	45/-	10B	10φ	2 19 6	45/-	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	38/- +1/-	10	10	5 5 3	39/6	29/6	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	61/3 +9d.	25	20	4 1 6	61/3	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	19/- +1/3	13	11½	3 8 6	19/3	13/9	16/1½	11/1½
2,500,000	5/-	Glynwed Tubes	29/-	22½	25¶	3 17 6	30/-	23/7½	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries ...	43/6	19L	16	3 15 6	44/6	34/9	41/9	33/-
696,780	10/-	Greenwood & Batley	26/-xcap +6d.	30W	30	5 15 6	27/-	23/9Z	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	12/9 +9d.	*20‡	*17½	3 18 6	13/6½	12/-	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	20/-	7	7	7 0 0	20/3	20/-	23/6	22/-
1,612,750	5/-	Heenan Group	15/- —4½d.	13	15	4 6 9	15/6	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries ...	72/3xd —1/6	13½	11½	3 16 0	74/7½	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/-	5	5	6 13 3	15/9	14/10½	18/-	15/4½
29,196,118	**	International Nickel	131½ +6½	$1.60	$1.50	2 2 0	131½	104	105	84½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/6	5	5	6 18 0	14/10½	14/-	16/6	14/6
6,000,000	1	Ditto Ord.	63/3	12	12D	3 16 0	63/9	59/6	67/6	44/9
600,000	10/-	Keith, Blackman	21/-	17½	17½E	8 6 9	21/6	18/3	32/6	17/6
320,000	4/-	London Aluminium	12/4½	12	10	3 17 6	12/6	8/6	12/6	7/10½
765,012	1	McKechnie Bros. Ord.	59/-	17½F	15F	5 18 9	59/-	53/6	71/6	57/3
1,530,024	1	Ditto A. Ord.	58/-	17½F	15F	6 0 9	58/-	53/3	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	17/3 —6d.	20%	20%	5 17 6	18/6	14/-	18/6	13/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/6	7½	7½	8 3 9	6/-	5/4½	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	89/6 —4/-	12M	13B	2 12 0	93/6	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	8/6	50	50	11 15 3	8/7½	6/9	10/9	7/1½
160,000	1	Mint (The) Birmingham	40/6 +2/-	12½	10	6 3 6	40/6	36/-	39/-	33/6
80,000	5	Ditto Pref. 6%	76/3	6	6	7 17 6	77/6	76/-	80/-	75/-
5,187,938	Stk. (£1)	Morgan Crucible A.	64/-	13	12	4 1 3	64/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	15/6	5½	5½	7 2 0	17/-	15/3	18/9	15/9
3,850,000	Stk. (£1)	Murex	46/6 —6d.	22½J	15	5 10 9	47/3	39/9	45/-	35/3
585,000	5/-	Ratcliffs (Great Bridge) Ord. ...	16/-xd	10	10R	3 2 6	16/6	16/-	17/-	14/9
195 000	5/-	Ditto 8% Max. Ord.	5/-	8	—	8 0 0	5/-	4/10½	5/3	5/-
1,064,880	10/-	Sanderson Kayser	37/6 +9d.	35‡	25	4 13 3	38/-	33/9	40/3	27/7½
3,400,500	Stk. (5/-)	Serck	16/9 —1/3	12½	17½GD	3 14 9	18/3	15/-	25/6	15/3
8,035,372	Stk. (£1)	Stone-Platt Industries	66/-	15	15	4 11 0	67/-	55/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/6	5½	5½	7 2 0	15/9	15/-	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	81/6 —1/6	14	20	3 8 9	85/6	72/3	140/3	63/10½
41,000,000	Stk. (£1)	Vickers	33/- —6d.	10	10	6 1 3	33/9	28/-	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref 5%	13/-	5	5	7 13 9	13/6	12/7½	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	20/6	*5	*5	7 5 0A	20/7½	19/9	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	78/- +2/-	13½	25	3 10 6	78/-	64/6	94/-	63/-
7,109,424	Stk. (£1)	Westinghouse Brake	41/9 +9d.	11	10	5 5 6	41/9	36/4½	60/6	37/6
323,773	2/-	Wolverhampton Die-Casting ...	10/9 +3d.	35	30	6 10 3	10/9	9/-	13/10½	8/1½
591,000	5/-	Wolverhampton Metal	29/6	32½	27½	5 12 0	30/-	24/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/6 +3d.	15	20‡	8 6 9	4/6	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	13/6	6	6	8 17 9	13/7½	13/6	15/-	13/6
150,000	1/-	Zinc Alloy Rust Proof	5/3 +3d.	40	30	7 12 6	5/3	4/6	5/4½	4/-

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% capitalized issue. ¤The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. D and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. R and 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units. φ and 6¼% from Capital Profits B and 50% capitalized issue. G and 1½d. special distribution. F and special 5% tax free dividend. H As forecast. ¶And 3 for 7 capitalized issue. L and 33⅓% capitalized issue. M and 10% capitalized issue. J and 75% capitalized issue. S and 40% capitalized issue. O calculated at 13⅓%. Interim on smaller capital P Calculated at 11⅓%. Q also 1/- special tax free dividend and 50% capitalized issue. T Per £1 unit. W Before capital reorganization. Calculated at 15%. Z After capital reorganization

MAGNESIUM

Foremost suppliers M E L of Magnesium Alloys

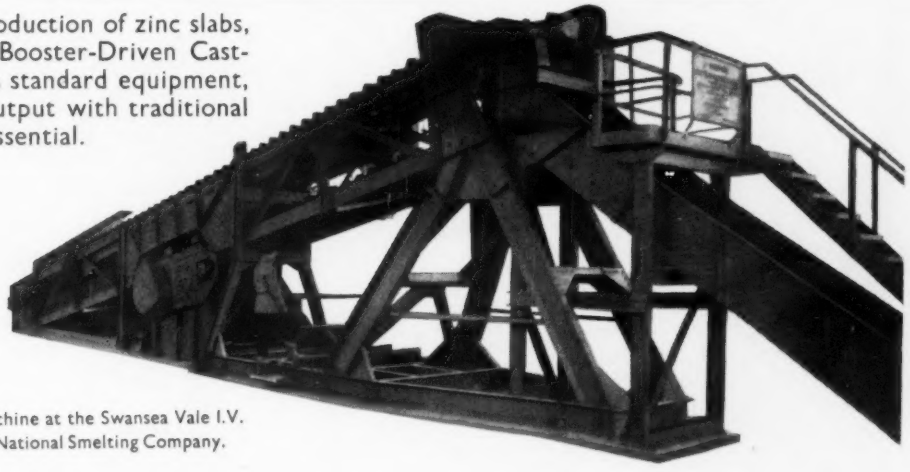
Magnesium Elektron Limited

Clifton Junction Manchester Swinton 2511
London Office : 5 Charles II Street SW1 Trafalgar 1646
Magnesium Elektron, Inc., New York 20, USA

SHEPPARD

BOOSTER DRIVEN ZINC SLAB CASTING MACHINE

For bulk production of zinc slabs, the Sheppard Booster-Driven Casting Machine is standard equipment, where high output with traditional slab finish is essential.



120 Mould Machine at the Swansea Vale I.V. Furnace Plant of the National Smelting Company.

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E

THE STOCK EXCHANGE

Steady Demand Again Reported

ISSUED CAPITAL *	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 17 APRIL	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	32/6		11	9	6 15 6	32/6	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/-		NIL	4	NIL	1/-	0/9	1/6	0/9
43,133,593	Stk. (£1)	Associated Electrical Industries ...	47/9	+3/-	15	15	6 5 9	54/10½	40/3	67/3	38/3
3,895,963	1	Birfield	62/6	—1/6	10	15‡	3 4 0	64/-	45/-	51/3	29/-
4,795,000	1	Birmid Industries	97/6	+1/6	20	20D	4 2 0	97/9	71/3	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	36/-	—6d.	17½QT	12½	3 6 0	36/10½	24/9	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/3	—3d.	5	5	7 0 3	14/4½	14/-	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	16/9	+3d.	6	6	7 3 3	17/6	16/9	20/-	17/1½
500,000	1	Bolton (Thos.) & Sons	48/9		12½	10	4 6 6	48/9	37/6	43/-	36/-
300,000	1	Ditto Pref. 5%	14/-		5	5	7 2 9	14/6	13/9	16/-	14/3
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	17/-		6	6	7 1 3	18/-	16/6	21/1½	17/7½
18,846,647	Stk. (£1)	British Insulated Callender's Cables	55/6	—3/-	13½	13½	4 17 3	59/9	50/4½	61/4½	47/-
20,456,599	5/-	British Oxygen Co. Ltd., Ord. ...	34/-	—1/3	16	16	2 7 0	35/3	26/3	35/-	19/10½
1,200,000	Stk. (5/-)	Canning (W.) & Co.	20/4½	+7½	15+8⅛C	25+*2½C‡	3 13 9	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/4½	—1½d.	NIL	12½	—	1/7½	1/-	2/3	1/-
555,000	1	Clifford (Chas.) Ltd.	28/-xd		12	10	8 11 6	29/-	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/3		6	6	7 17 6	15/3	15/1½	16/-	15/10½
300,000	2/-	Coley Metals	4/3	+9d.	15	15	7 1 3	4/2½	3/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	77/-	+5/9	20	15	5 4 0	77/-	64/-	80/9	59/6
5,399,056	1	Davy-Ashmore	172/6	—3/6	30‡	20	1 12 8	177/6	129/6	147/3	99/6
8,000,000	5/-	Delta Metal	24/6xd	+9d.	20	17½	4 1 9	25/4½	19/9	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	45/3xd	—3/3	15	15	6 12 6	52/3	45/-	56/9	45/-
1,155,000	1	Evered & Co.	45/-		10B	10φ	2 19 6	45/-	42/6	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	38/-	+1/-	10	10	5 5 3	39/6	29/6	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	61/3	+9d.	25	20	4 1 6	61/3	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	19/-	+1/3	13	11½	3 8 6	19/3	13/9	16/1½	11/1½
2,500,000	5/-	Glynwed Tubes	29/-		22½	25¶	3 17 6	30/-	23/7½	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries ...	43/6		19L	16	3 15 6	44/6	34/9	41/9	33/-
696,780	10/-	Greenwood & Batley	26/-xcap	+6d.	30W	30	5 15 6	27/-	23/9Z	33/6	29/1½
792,000	5/-	Harrison (B'ham) Ord.	12/9	+9d.	*20‡	*17½	3 18 6	13/6½	12/-	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	20/-		7	7	7 0 0	20/3	20/-	23/6	22/-
1,612,750	5/-	Heenan Group	15/-	—4½d.	13	15	4 6 9	15/6	10/6	13/-	9/10½
251,689,407	Stk. (£1)	Imperial Chemical Industries ...	72/3xd	—1/6	13½	11½	3 16 0	74/7½	63/1½	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	15/-		5	5	6 13 3	15/9	14/10½	18/-	15/4½
29,196,118	**	International Nickel	131½	+6½	$1.60	$1.50	2 2 0	131½	104	105	84½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	14/6		5	5	6 18 0	14/10½	14/-	16/6	14/6
6,000,000	1	Ditto Ord.	63/3		12	12D	3 16 0	63/9	59/6	67/6	44/9
600,000	10/-	Keith, Blackman	21/-		17½	17½E	8 6 9	21/6	18/3	32/6	17/6
320,000	4/-	London Aluminium	12/4½		12	10	3 17 6	12/6	8/6	12/6	7/10½
765,012	1	McKechnie Bros. Ord.	59/-		17½F	15F	5 18 9	59/-	53/6	71/6	57/3
1,530,024	1	Ditto A. Ord.	58/-		17½F	15F	6 0 9	58/-	53/3	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	17/3	—6d.	20%	20%	5 17 6	18/6	14/-	18/6	13/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/6		7½	7½	8 3 9	6/-	5/4½	6/6	5/9
26,361,444	Stk. (£1)	Metal Box	89/6	—4/-	12M	13B	2 12 0	93/6	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	8/6		50	50	11 15 3	8/7½	6/9	10/9	7/1½
160,000	1	Mint (The) Birmingham	40/6	+2/-	12½	10	6 3 6	40/6	36/-	39/-	33/6
80,000	5	Ditto Pref. 6%	76/3		6	6	7 17 6	77/6	76/-	80/-	75/-
5,187,938	Stk. (£1)	Morgan Crucible A.	64/-		13	12	4 1 3	64/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	15/6		5½	5½	7 2 0	17/-	15/3	18/9	15/9
3,850,000	Stk. (£1)	Murex	46/6	—6d.	22½J	15	5 10 9	47/3	39/9	45/-	35/3
585,000	5/-	Ratcliffs (Great Bridge) Ord. ...	16/-xd		10	10R	3 2 6	16/6	16/-	17/-	14/9
195,000	5/-	Ditto 8% Max. Ord.	5/-		8	—	8 0 0	5/-	4/10½	5/3	5/-
1,064,880	10/-	Sanderson Kayser	37/6	+9d.	35‡	25	4 13 3	38/-	33/9	40/3	27/7½
3,400,500	Stk. (5/-)	Serck	16/9	—1/3	12½	17½GD	3 14 9	18/3	15/-	25/6	15/3
8,035,372	Stk. (£1)	Stone-Platt Industries	66/-		15	15	4 11 0	67/-	55/-	64/4½	52/3
2,928,963	Stk. (£1)	Ditto 5½% Cum. Pref.	15/6		5½	5½	7 2 0	15/9	15/-	18/7½	15/3
35,344,881	Stk. (£1)	Tube Investments Ord.	81/6	—1/6	14	20	3 8 9	85/6	72/3	140/3	63/10½
41,000,000	Stk. (£1)	Vickers	33/-	—6d.	10	10	6 1 3	33/9	28/-	39/7½	27/1½
750,000	Stk. (£1)	Ditto Pref 5%	13/-		5	5	7 13 9	13/6	12/7½	17/6	13/3
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	20/6		*5	*5	7 5 0A	20/7½	19/9	24/6	20/1½
4,594,418	1	Ward (Thos. W.) Ord.	78/-	—2/-	13½	25	3 10 6	78/-	64/6	94/-	63/-
7,109,424	Stk. (£1)	Westinghouse Brake	41/9	+9d.	11	10	5 5 6	41/9	36/4½	60/6	37/6
323,773	2/-	Wolverhampton Die-Casting ...	10/9	+3d.	35	30	6 10 3	10/9	9/-	13/10½	8/1½
591,000	5/-	Wolverhampton Metal	29/6		32½	27½	5 12 0	30/-	24/6	39/9	23/9
156,930	2/6	Wright, Bindley & Gell	4/6	+3d.	15	20‡	8 6 9	4/6	3/7½	4/6	2/10½
124,140	1	Ditto Cum. Pref. 6%	13/6		6	6	8 17 9	13/7½	13/6	15/-	13/6
150,000	1/-	Zinc Alloy Rust Proof	5/3	+3d.	40	30	7 12 6	5/3	4/6	5/4½	4/-

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. **Shares of no Par Value. ‡ and 100% capitalized issue. *The figures given relate to the issue quoted in the third column. A Calculated on £7 8 9 gross. D and 50% capitalized issue. C paid out of Capital Profits. E and 50% capitalized issue in 7% 2nd Pref. Shares. B and 33⅓% capitalized issue in 8% Maximum Ordinary 5/- Stock Units. φ and 6½% from Capital Profits B and 50% capitalized issue. G and 1½d. special distribution. F and special 5% tax free dividend. H As forecast. ¶And 3 for 7 capitalized issue. L and 33⅓% capitalized issue. M and 10% capitalized issue. J and 75% capitalized issue. S and 40% capitalized issue. O calculated at 13¾%. Interim on smaller capital P Calculated at 11½%. Q also 1/- special tax free dividend and 50% capitalized issue. T Per £1 unit. W Before capital reorganization. Calculated at 15%. Z After capital reorganization

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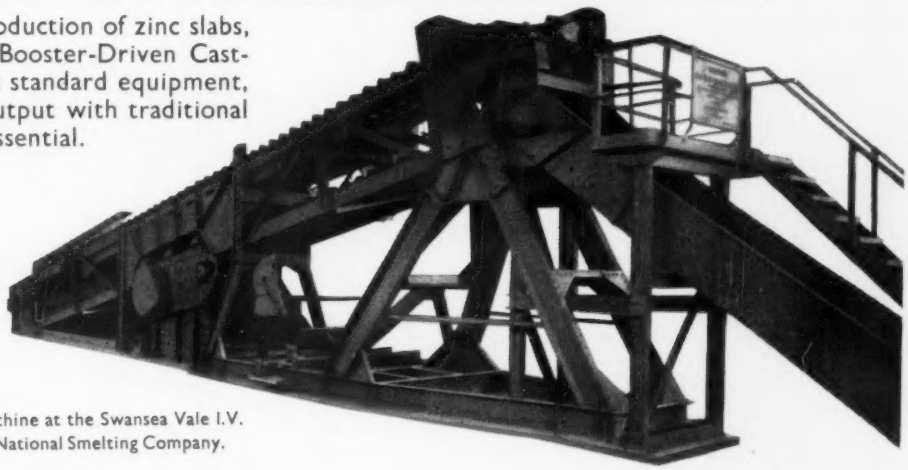

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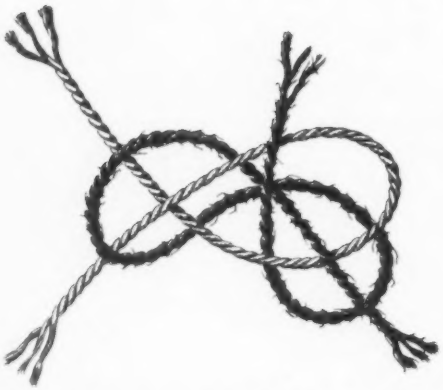

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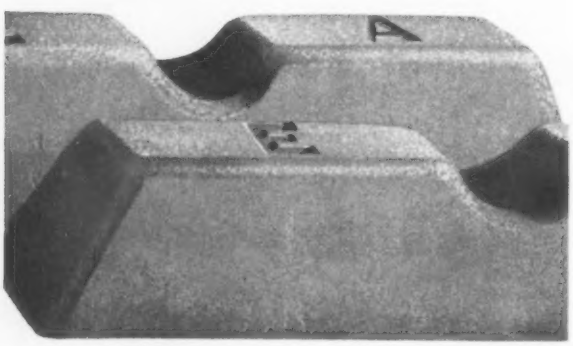

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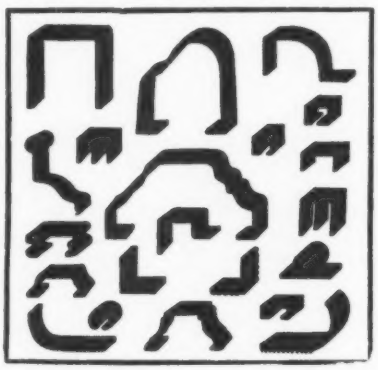

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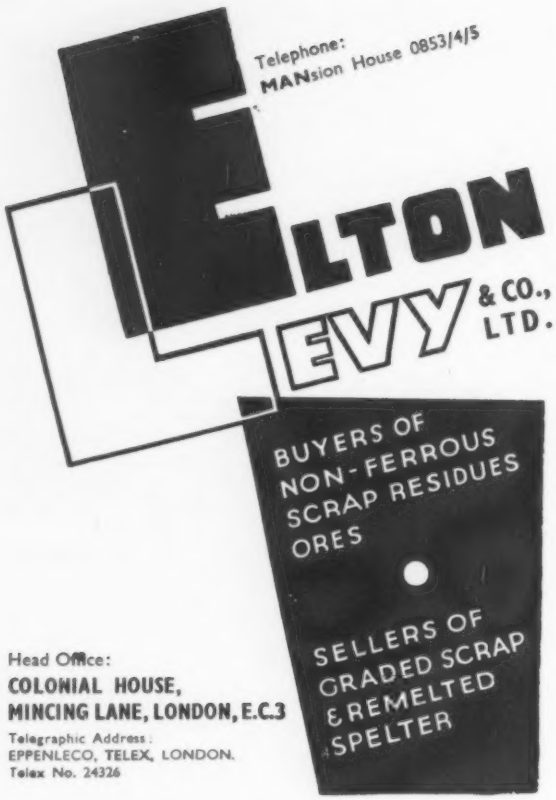

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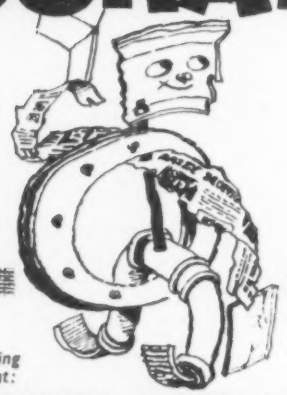

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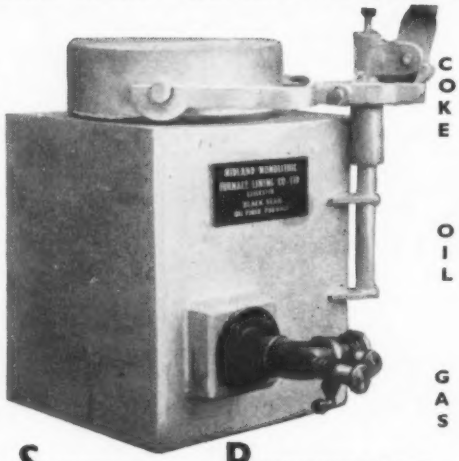

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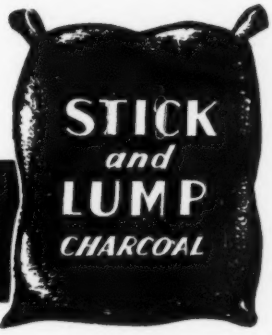

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